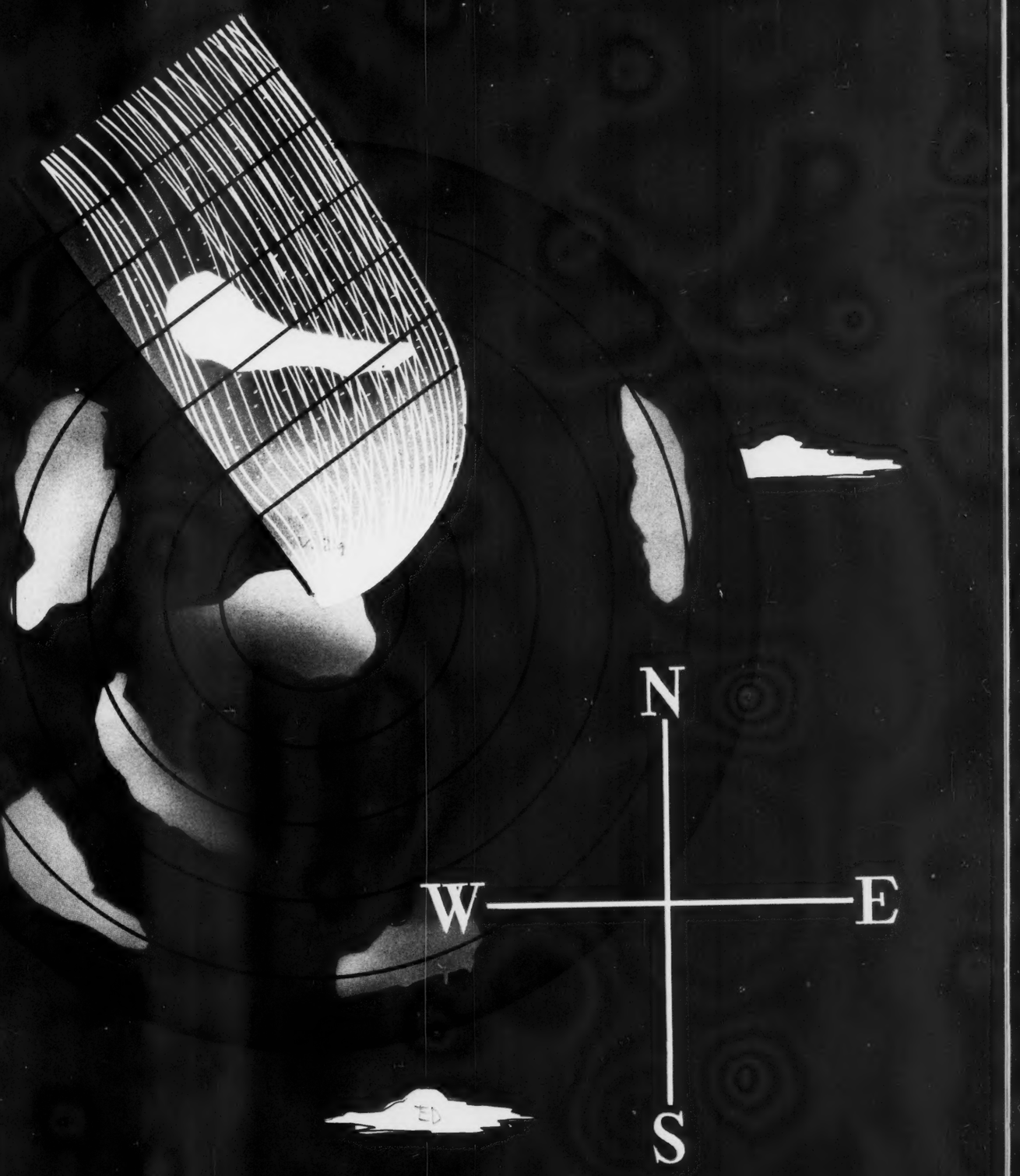
he tech engineering news



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Eng
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A LITTLE DOES A LOT

According to legend, when the city of Carthage was founded, Queen Dido was told that she could have only as much land as could be encompassed by an ox hide. But the queen made the most of her material by cutting it into a single, continuous leathern string, with which she circled considerable acreage.

Making materials serve to the fullest is just as important to users of steel today as it was to Dido. Except that today no tricks are necessary.

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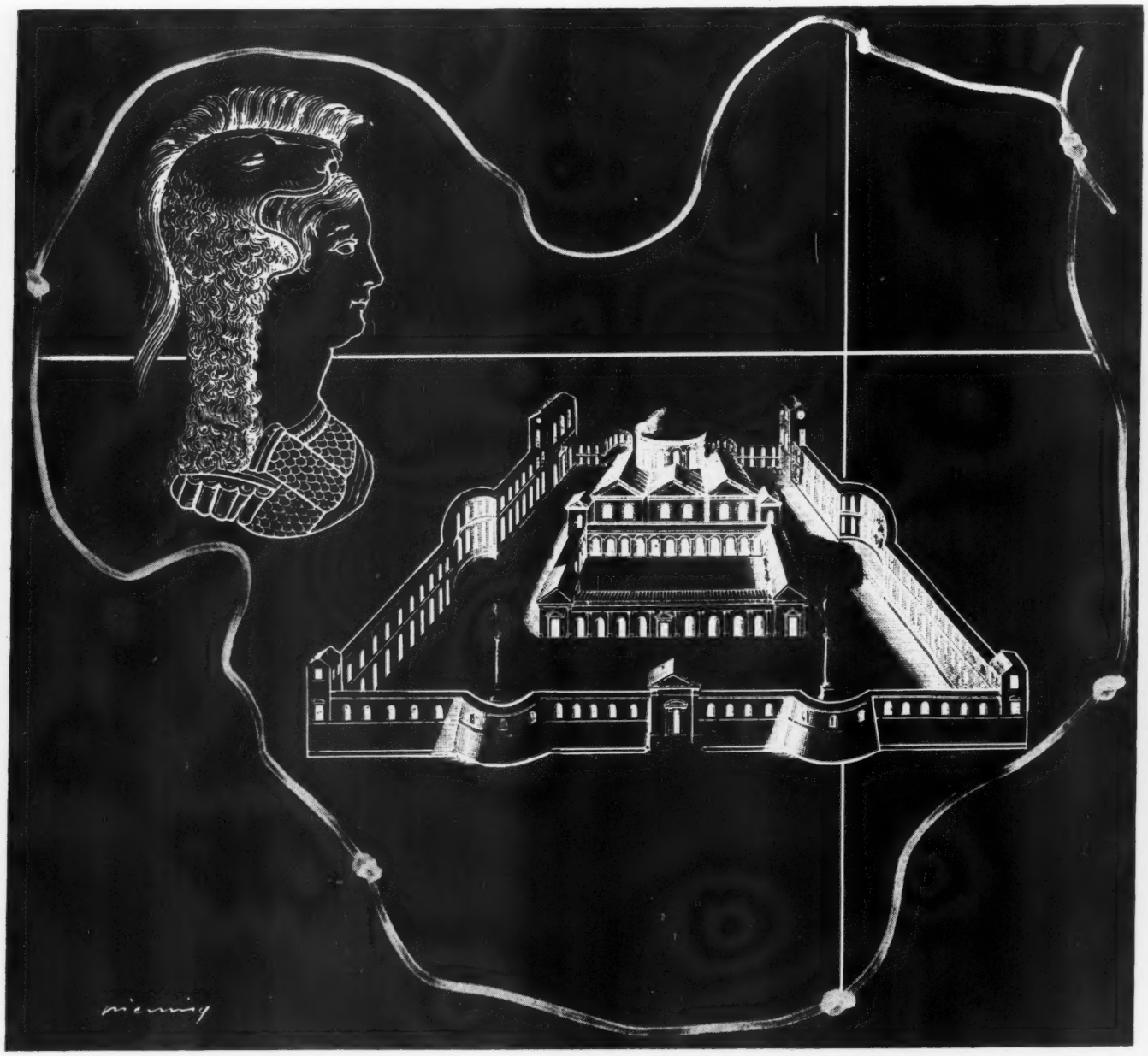

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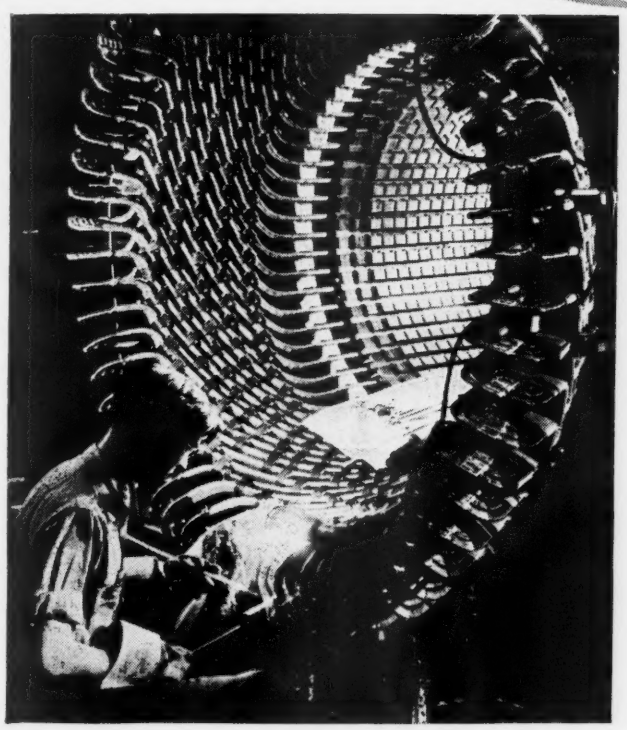

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to show production people how to turn out the product after it has been designed.

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to improve efficiency in methods of production.

PRODUCTION CONTROL ENGINEERS . . .
to get the right materials at the right place at the right time.

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to supervise inspection of materials and workmanship at every step in the process of manufacture, and help develop the highest standards.

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PLANT LAYOUT ENGINEERS . . .
to plan installation of new manufacturing facilities or revamping of the old.

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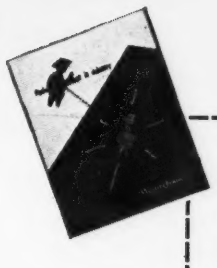
G-10002



This is but *one* of the many opportunities open in the electrical field. There are many others—in sales, research and engineering at Westinghouse. Begin plans for your future by sending today for your free copy of "Finding Your Place in Industry".

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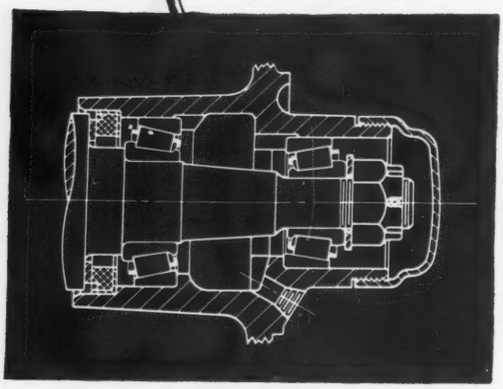
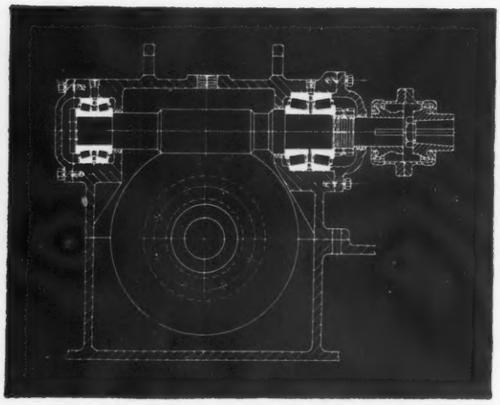
What Every Student Engineer Should Know About Bearing Functions



TRACTOR FRONT WHEEL in which both thrust and radial loads are carried on single row Timken Bearings. From whichever way the load may come, it will be handled with minimum friction and wear.



APPLICATION of Timken Bearings on the worm shaft of a worm gear drive. The load on the worm shaft bearings, due to the operation of the worm, is primarily thrust. There is considerable radial load however, arising from the separating force of the gears and also possibly from overhung driving loads. This is another application for which the tapered roller bearing is ideal.

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Practically every bearing application in equipment of all kinds involves the carrying of radial and thrust loads in varying degrees. These drawings show how Timken Tapered Roller Bearings effectively perform both functions.

Because it is a *roller* bearing, the Timken Bearing can carry the heaviest loads. Because it is a *tapered* roller bearing it can carry both radial and thrust loads — separately or in any combination.

From whichever direction loads may come, its tapered design enables the Timken Bearing to carry them all with full efficiency and safety. The cost and complication of a separate type of bearing for each kind of load are eliminated. Bearing housings and mountings are simplified — with savings in cost, weight and space.

The more you learn about Timken Bearings now, the better prepared you will be to solve any bearing problems you may encounter in the future.

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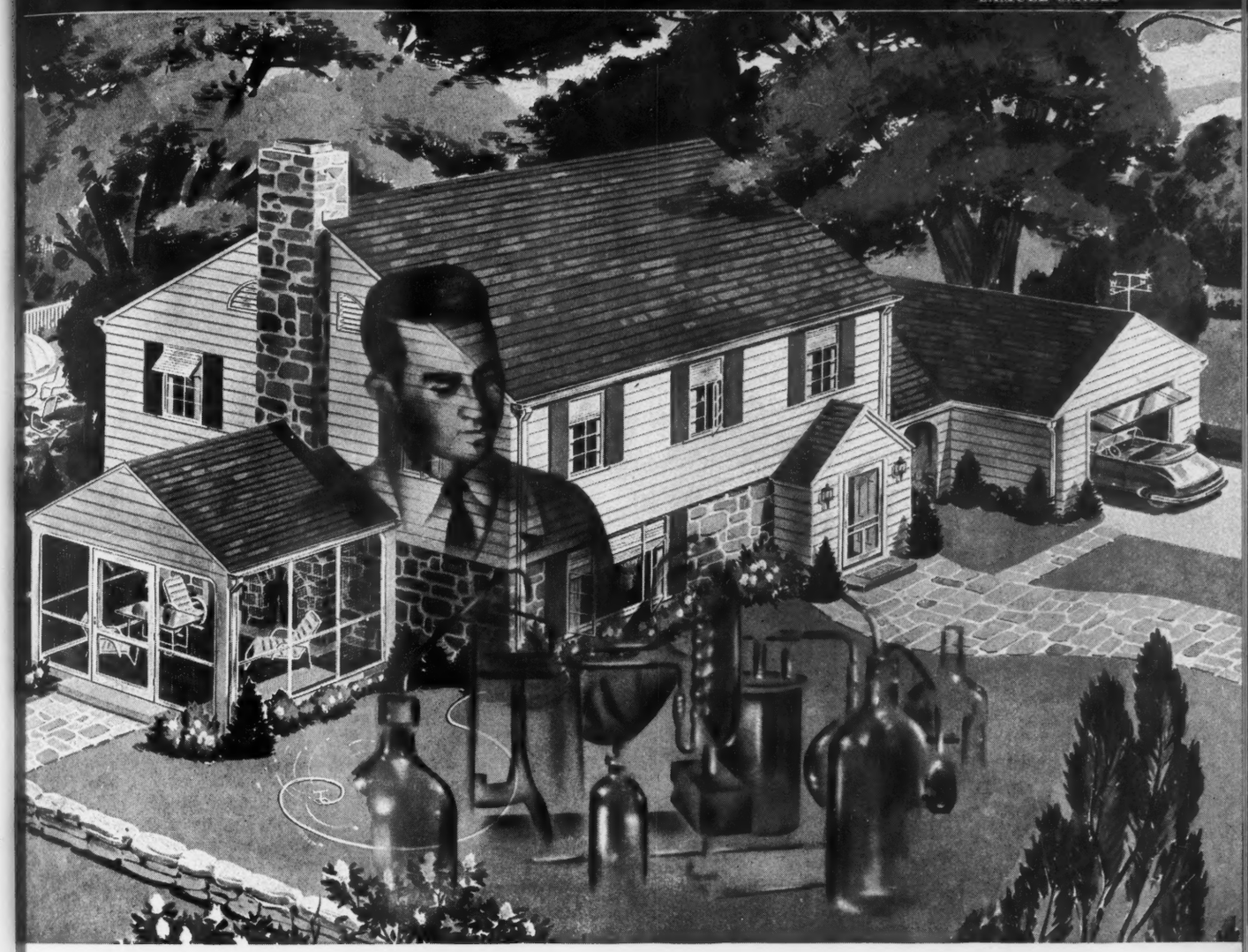
TAPERED ROLLER BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

"The great highroad of human welfare lies along the old highway of steadfast well-doing"
—SAMUEL SMILES



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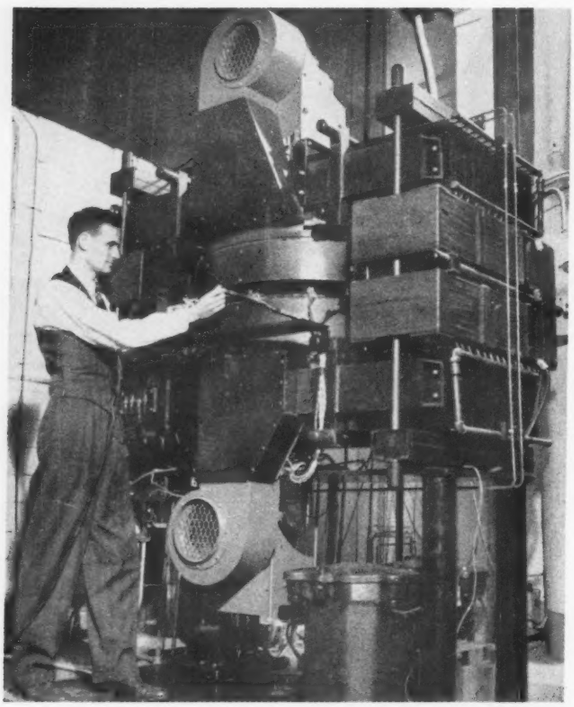
Briefing the News . . .

The Electron Becomes Visible . . .

FOR the first time, scientists have been able to catch a glimpse of the electron. Operating a 70,000,000-volt synchrotron, a modification of the renowned cyclotron or "atom smasher," Floyd Haber, an assistant in the General Electric Company's laboratory in Schenectady, N. Y., noticed a bluish-white light coming from the interior of the instrument. Physicists in charge of the project checked the instrument to be sure that it was in working order, and then came to the conclusion that the blue light could only have come from electrons which were being circulated through the machine. Until then, electrons had been detected only by secondary effects, which they produce in passing through an ionizable gas or in crashing headlong into matter like the fluorescent screen of a television tube. The electron light given off by the G. E. synchrotron, however, came directly from the electrons themselves, as a consequence of their moving in a circular path at extremely high velocities.

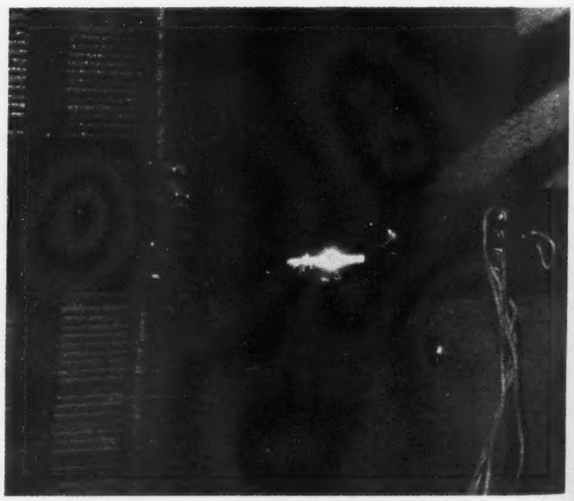


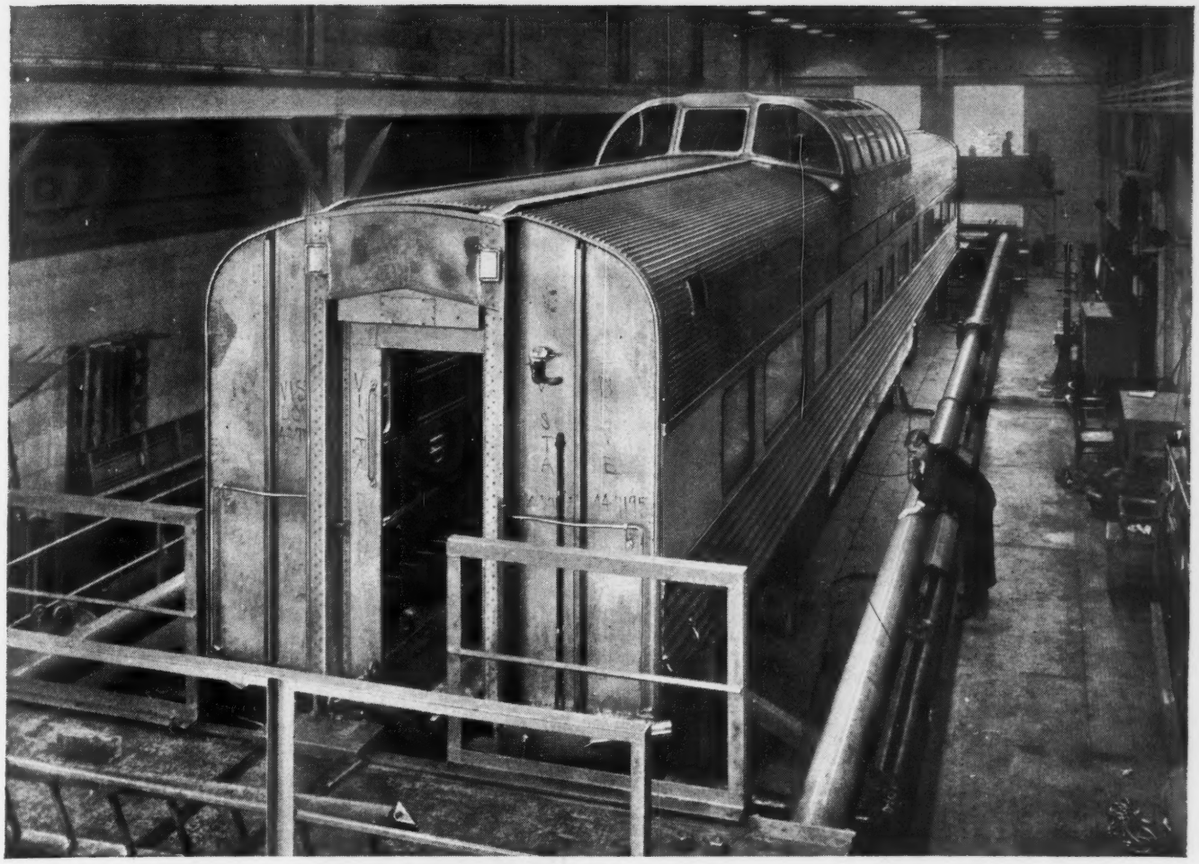
Inside the synchrotron, electrically charged particles, in this case electrons, are accelerated by electrostatic fields to higher and higher velocities, while constrained to move in a circular path by a powerful magnetic field at right angles to the plane of their motion. As the electrons approach the critical velocity of light, they emit radiation in their direction of motion, first in the radio frequency region, and then successively in the infrared, visible, ultraviolet and X-ray portion of the electromagnetic spectrum as higher and higher velocities are reached. The emission of radio waves by electrons has been the principle upon which radio communication is based. The radio transmitter causes electrons to travel back and forth rapidly in a conductor known as the antenna, thus emitting radio frequency waves. As these waves strike the antenna of a radio receiver, the energy of the radio waves is reconverted into the kinetic energy of moving electrons, and the current thus produced is detected and amplified by the receiving set.

During the war, two Russian scientists, Iwanenko and Pomeranchuk, predicted that visible light would be produced by electrons accelerated to near the velocity of light in a betatron, a form of particle-accelerator especially designed for electrons. When the electrons have a kinetic energy of around 100,000,000 electron volts (corresponding to the energy gained by an electron accelerated across an electric field of 100,000,000 volts), according to the Russian scientists, they would radiate energy in electromagnetic waves as fast as it was supplied by the betatron. A number of betatrons have been built, but the emission of light has never been observed because of their opaque construction. Even though the vacuum chamber containing the moving electrons is constructed of glass, the glass has been coated with a thin metallic film to conduct away electrons that wander from the narrow path and strike the walls of the instrument. The G. E. synchrotron, however, is coated with a transparent layer that is electrically conducting like a metallic layer. As a result, the light given off by the electron stream could be observed. All of it was found to be emitted within the very narrow angle of ½° of the direction of motion of the electrons.

In addition to its interest in proving visually that electrons really do exist, the phenomenon will be of great use to physicists in determining the relations of matter and energy at high velocities. It may also help physicists in keeping track of the position of electrons in synchrotrons, betatrons, and other similar instruments. The electrons in any of these modifications of the cyclotron are "bunched" by the effect of the electrostatic field, so that they all travel around the vacuum chamber together. In the operation of a synchrotron, the electric field must be alternated in direction at just the right moment so that the electrons will be accelerated rather than decelerated by the electric field. By the new method, it may be possible to tell, with the aid of the photoelectric cell, exactly where the mass of electrons is at any instant, and thus the alternations of the electric field can be synchronized exactly with the period of travel of the electrons in their circular orbits.

(*Continued on page 46*)





Interior view of a section of the Budd Test Plant showing a Vista-Dome car, built for the Burlington, undergoing compression tests. Forces up to 2,000,000 pounds can be applied by this machine.

RESEARCH SERVICE NOW AVAILABLE TO ALL RAILROADS AND MANUFACTURERS

In building stainless steel railroad cars, we have continuously explored many scientific fields in which there was no railroad precedent.

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We now wish to make their services, and the facilities at their command, available to railroads and railroad equipment manufacturers. It is our conviction that the welfare of railroading demands the broadest and most intense application of science to guide and accelerate its progress.

This service is offered at cost.

We have just completed a booklet describing Budd Railway Research Service which we will be glad to send you upon request. The Budd Company, Philadelphia.

Budd

LIFETIME MAINTENANCE COST OF A RAILROAD CAR EXCEEDS ITS PURCHASE PRICE

Courtesy of Science Illustrated

Captain Bjorn Arnold Rorholt, Los Angeles, Calif.
c/o Norwegian Embassy
Washington, D. C.

Dear OM,

I have the answers to the questions regarding the radio equipment on the Kon-Tiki; I will first put the question as sent to them and then their reply

1 – Q, Have you tried generator GN58 for receiver?
A, No.
2 – Q, How many batteries did you take?
A, All. 41 six volts and 30 forty-five volts.
3 – Q, Is there any difference in output between generator and battery operation?
A, Not tried yet.
4 – Q, Are you using 6995 KC crystal from the ten meter rig?
A, Yes, but ten meter rig in use too.
5 – Q, Have you removed last audio valve in 173 Receiver?
A, Tried, but receiver then too weak.
6 – Q, What kind of antenna do you normally use?
A, L antenna
7 – Q, Have you tried balloon or kite supported antennas?
A, Both tried.
8 – Q, Have you tried voice modulation since shortly after leaving Peru?
A, Yes, results not good.
9 – Q, Do you use mark two transmitter?
A, Yes, and then very good.
10 – Q, How does the NC-173 stand up under conditions on board?
A, Excellent.
11 – Q, How many hours can you operate the transmitter on one set of batteries?
A, High tension batteries very long life but long articles kill our heater batteries.

In case you did not hear me yesterday their heater batteries are used but Raaby tells me that they make 1½ volt units from their 45 volt batteries and then use four of these for six volts and thus get about four days service from each set. They have about five sets left so are O.K. for sometime yet.

"Pen" sends his vy 73 to you as do I and I hope to work you again soon. I am anxious to meet the boys but I am also going to miss these daily contacts with the raft.

I hope Knut, and Torstein keep up their radio and get on the air when they get back to Norway for I would enjoy very much keeping up our friendship via amateur radio.

Again VY73 to you Pronto and hope to cul.

Very Sincerely,

HAL —W6EVM

NC-173

Frequency coverage from 540 KC to 31 mc plus the 48-56 mc range. Calibrated amateur band spread on 6, 10-11, 20, 40 and 80 meter bands.

Amateur Net....NC-173 (with speaker) $189.50

National
NC
EST 1914

The press of the entire country has carried stories concerning the day-to-day activities of the 6 young Norwegian scientists, members of the Kon-Tiki Expedition, who set out on a raft to drift more than 5000 miles across the Pacific Ocean.

Very little mention has been made, however, of the battery-powered transmitter and model NC-173 receiver which allowed the Expedition to dispatch over 500 messages and 30,000 words.

These figures furnish one more proof that a National receiver in the hands of a good operator makes an unbeatable combination.

National Company, Inc.
Dept. No. 99
Malden, Mass.
U. S. A.

MAKERS OF LIFETIME RADIO EQUIPMENT

The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL
OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

Volume XXIX, No. 1

NOVEMBER, 1947

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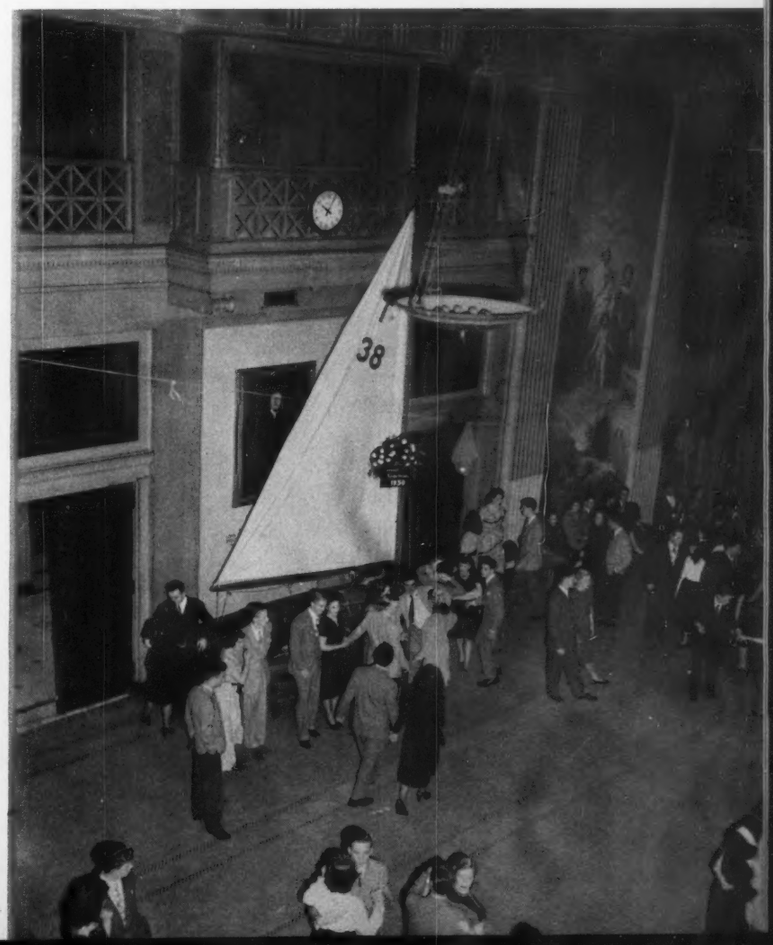

MEMBER OF THE
ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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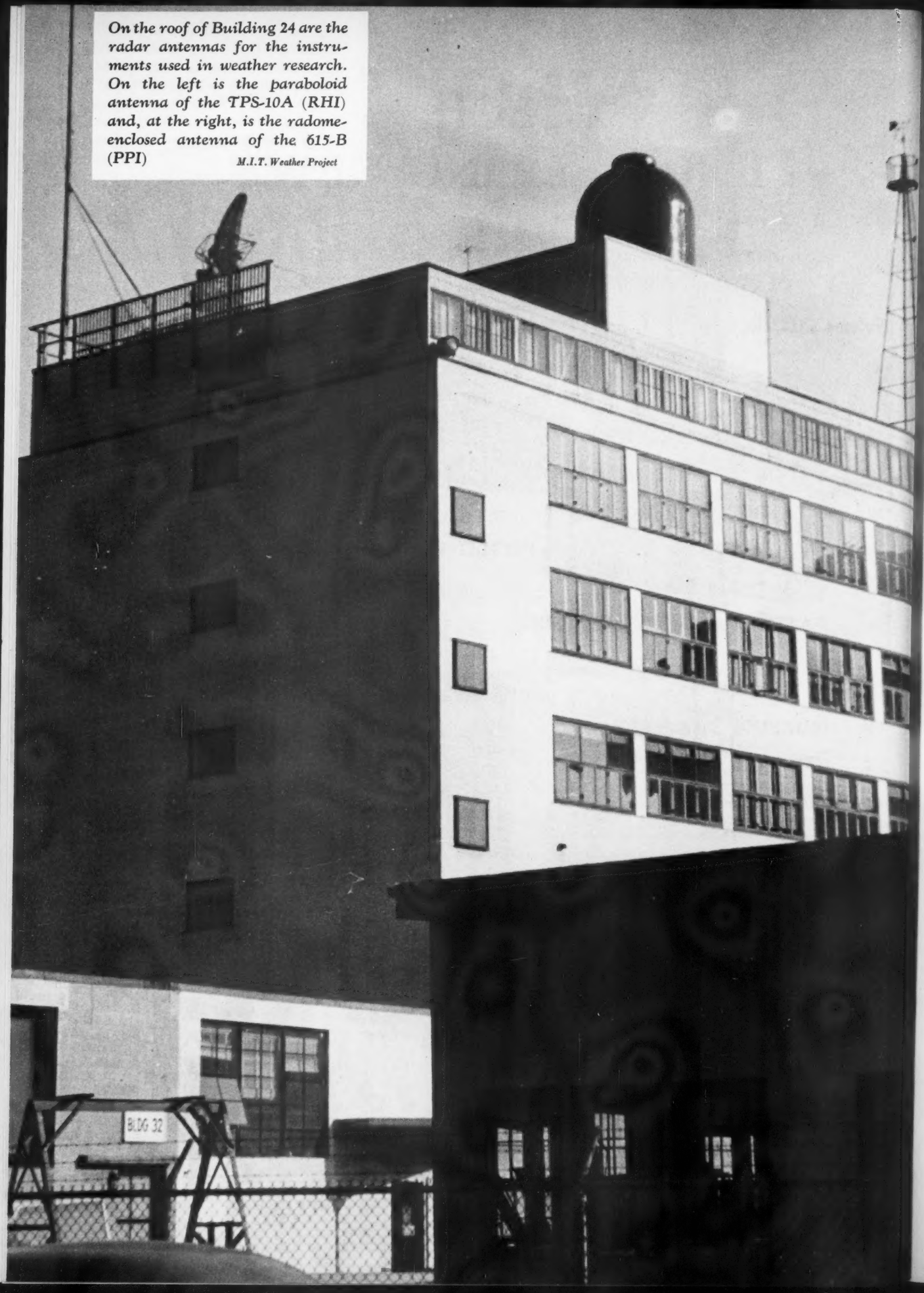


On the roof of Building 24 are the radar antennas for the instruments used in weather research. On the left is the paraboloid antenna of the TPS-10A (RHI) and, at the right, is the radome-enclosed antenna of the 615-B (PPI) *M.I.T. Weather Project*

An Eye for Weather

By HARRISON C. WHITE, '50

AN/TPS-10A, as most any former RT will know, is the designation of the microwave radar set whose crescent (actually paraboloid) shaped antenna, mounted seven stories high on the roof of Building 24, every now and again seesaws up and down — apparently just to give Tech men something on which to speculate. Under the nearby treated-canvas radome stands the antenna of a SCR 615-B, another microwave set.

Both of these microwave sets, as well as much other equipment described hereinafter, are being used in investigations of our fabulous Boston weather by a project under the M.I.T. Meteorology Department. This year-old project, which involves upwards of twenty men, is directed by a Technology research associate, Alan C. Bemis, under a Signal Corps contract.

Its purposes are several: to increase the fund of observational material in the form of photographs of PPI (Plan Position Indicator), RHI (Range Height Indicator) and "A" scope views of clouds, storms, and associated meteorological phenomena; to compare the radar scope view of a given storm area with the actual meteorological properties of that storm area as measured simultaneously by the project's Flying Fort (B17) and thus obtain a correlation between the nature of the radar echoes and the associated clouds or rain areas; and by using the accumulated observational material, to both improve weather radar techniques and equipment and develop a better understanding of the basic phenomena of precipitation, cloud formation, and related basic factors in weather formation.

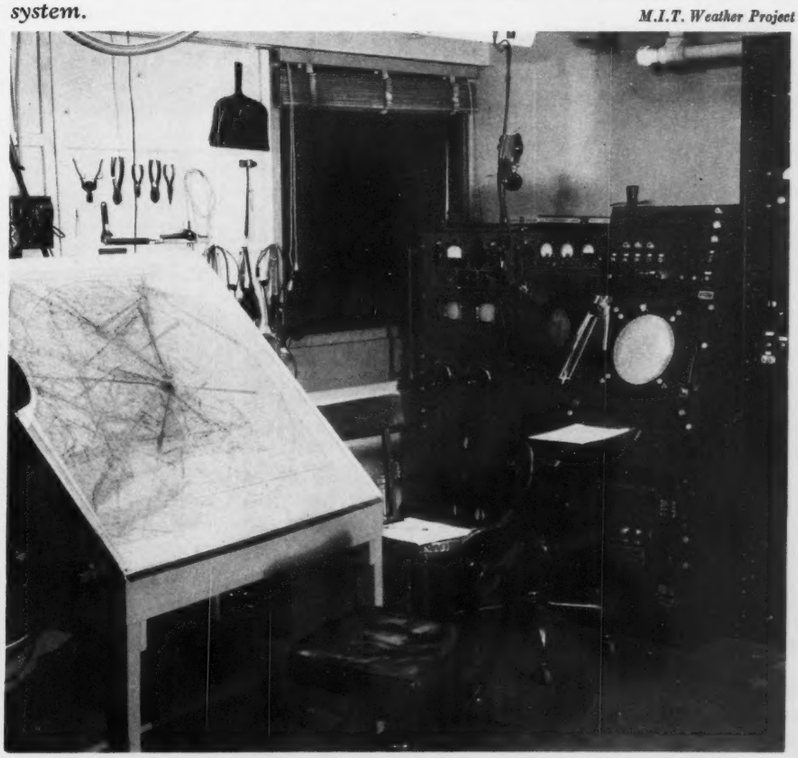
There is already in the field of weather radar a considerable literature, the product of other projects. Back in the early days of the war, during the first work with microwave radar at the Radiation Lab, it became evident that atmospheric water would be an important factor to consider in the operation of microwave sets. Many military weather forecasting systems, notably that in Panama, soon made use of microwave radar. The Signal Corps Weather Radar Section, the AAF Weather Service, the Air Technical Service Command, the Navy, and the Canadian Army Operational Research Group all maintain or maintained weather investigation projects — almost all of an immediately practical nature. In addition to these service projects the United States Weather Bureau sponsors the "Thunderstorm Project," the aim of which is to make a fundamental and detailed study of the physics of thunderstorms.

First, a survey of a little basic theory before we go to specific description of the project. The fundamentals underlying all radar systems are easily understood: High powered, very high frequency (1200–30,000 megacycles in the case of microwaves) electromagnetic waves generated in short microsecond pulses by the transmitter are beamed by a directional antenna at the volume of space under investigation, the pulse repetition rate (prf) being so determined that a given pulse has time to travel out to the maximum desired range and — if it meets a suitable object — be reflected back to the antenna before the next pulse. The returned pulse is fed from the antenna to the vertical deflection plates of a cathode ray — or another similar — tube. This tube's horizontal sweep speed has been previously set so that the electron beam is started at the instant the pulse is transmitted and continues at a constant speed across the scope — all the while subject to vertical deflection from returning echoes — to be turned off at the end of the scope just at the time an echo from the maximum range would be received.

Of course, simple "A" scope presentation, as described above, is not always the most desirable. PPI

A view of the radar operating room. The drafting table simultaneously plots the radar views and the observations taken of the B-17. The circular screen at right is the scope of the PPI set. A technician sits at the chart table during actual operation and directs the movements of the B-17 through a VHF intercom system.

M.I.T. Weather Project



M.I.T. Weather Project

Meteorological instruments instead of guns project from the nose and wings of this Army B-17. The plane is equipped to radiate both "S" and "X" band beacons so that it can be more easily traced by ground radar.

projection gives a bird's-eye view presentation of space as presented by a rotating antenna, while RHI presentation gives a vertical cross sectional view of space along a given azimuth as presented by an antenna oscillating up and down. The R scope is a refinement of the of the A scope whereby any chosen eight mile section of the A scope is magnified to full scale on the R scope. All of these presentation systems are fundamentally similar.

In applying radar to weather investigation, it is first of all essential to operate in the microwave part of the spectrum (wavelength between 1 and 25 cms.) as it is only in this region that rain and snow reflect radar waves effectively. It is also important that the beam be as sharply defined as is practical in order that as small a volume of space as possible can be investigated at any one time.

The principal characteristics of radar weather echoes under investigation by the M.I.T. project are their appearance and location as represented on the PPI and RHI scopes, the echo strength as measured by a pulse integrator device, and the fluctuation frequency of echo strength. This fluctuation is caused by the change of interference effects between individual raindrops due to their relative motion.

It is thought that a correlation exists between echo intensity and storm or cloud intensity. Theoretical considerations of a rather advanced nature lead to the equation:

$$P_r = \frac{P_t A_p^2 \sigma}{9\pi R^4 \lambda^2}$$

where P_r = returning power; P_t = transmitted power; A_p = area of the paraboloid antenna; σ = the radar scattering cross section of given volume, which is defined as "the area intercepting that amount of power which, if scattered isotropically, would give an echo equal to that from the target"; R = range; and λ = wavelength. σ in turn is determined by the equation:

$$\sigma = V \int_0^\infty n(a)\sigma(a)da$$

where V is a unit of pulse volume, $n(a)$ gives drop size distribution, and $\sigma(a)$ gives scattering cross section of a single drop — defined as an involved function of drop radius and wavelength.

Therefore P_r is a function of, among other variables, the drop size distribution and hence, probably, the intensity of the storm. P_r actually turns out to be, according to theory, roughly proportional to Na^6, where N is the number of drops of radius a per unit volume.

By empirical observations it was found that, roughly,

$$P_r \propto M^{2.1}$$
$$P_r \propto p^{2.0}$$
$$P_r \propto D_{\max}^{5.7}$$

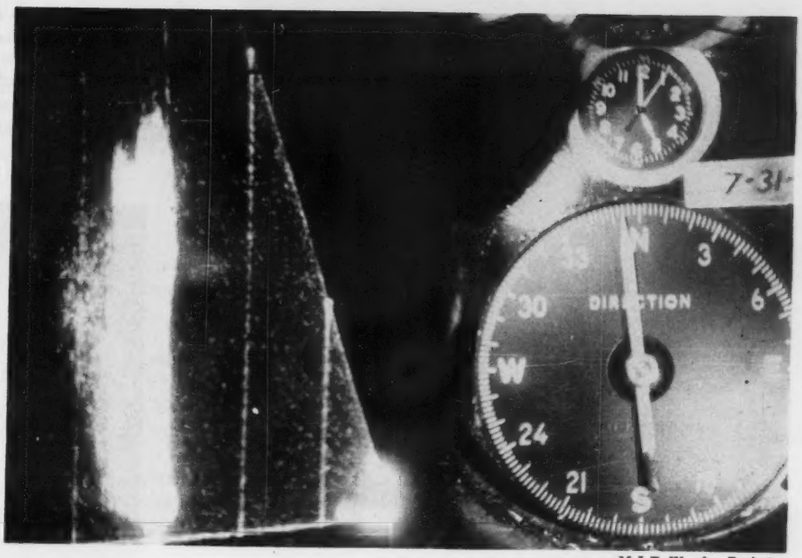
where M is the mass per unit volume, p is precipitation rate, and $D_{\max}$ is the maximum drop diameter. Therefore both theoretical and empirical investigations lead us to the conclusion that P_r is proportional to the intensity of the storm. However, the question of whether the intensity of a storm can be determined by the intensity of its radar echo is still not decided, since P_r is not a function of raindrop size and number only. One of the objects of the project is to see if echo intensity is quantitatively related to storm intensity, and if

not, to investigate some theories which explain this lack of correspondence.

The frequency of fluctuation of the strength of pulse echoes is in the audio-frequency range. Since this fluctuation is a result of the relative motion of the water droplets in the cloud or storm it is possible that the turbulence of a cloud can be determined by the frequency spectrum of its echo. The frequency spectrum is given by the equation:

$$F(w) = \frac{\lambda}{2\pi}\int_{-\infty}^{\infty} S(w)S\left(u+\frac{\lambda w}{4\pi}\right)du$$

where $S(u) = \int_0^{\infty} w(r,u)dr$ and represents the fraction of the echo power returned by drops whose velocity is between u and $u+du$ and in the direction of the beam. However, although this relation shows that the turbulence (velocity distribution) is a function of the frequency, it is not a unique function; so its exact relationship remains to be determined experimentally.

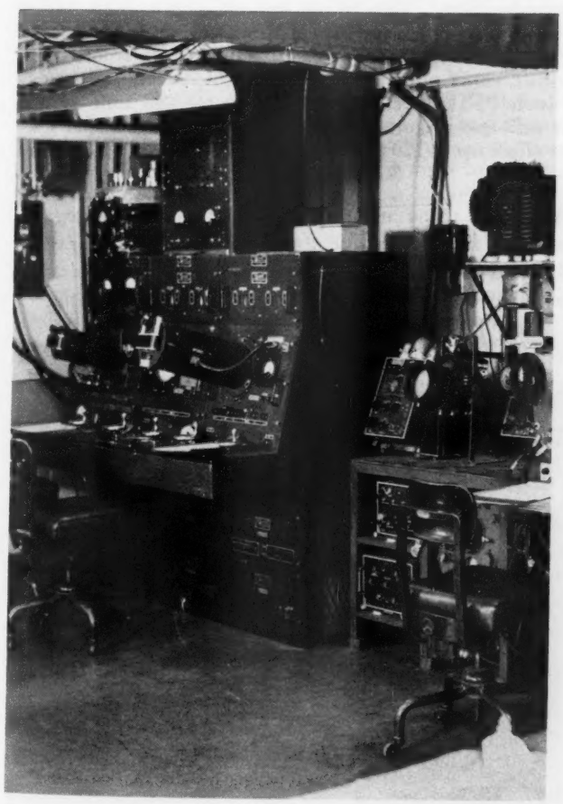


M.I.T. Weather Project

This is a sectional view on an azimuth 6° west of north through the storm front shown on the PPI scope view, page 12. The front is six miles thick and covers a range of altitude from 35,000 feet down to the ground, where it is either raining or snowing. The bright spot at the right of the radar view represents Boston.

Operating room. The projecting cylinders contain cameras attached to the radar scopes to record permanently the results of each experiment.

M.I.T. Weather Project



The whole investigation of the relation between radar echoes and the target phenomena would be much easier if the mechanisms of the cloud formation, rainstorms, etc. were understood, but such, unfortunately, is not the case. Actually, surprisingly little is understood of the physics of even the most important meteorological phenomena. Raindrop formation, for example is not adequately explained, although there are a number of theories extant treating different parts of the whole phenomenon.

It is fairly well established that all droplets must have a nucleus on which to form. It is furthermore granted that unless the relative humidity is considerably greater than 100 per cent, the nucleus must be of a hygroscopic nature, for the radius of the nucleus is necessarily small — and ease of condensation of water vapor is directly proportional to the radius of the nucleus, which is originally less than half a micron in diameter. Usually sea salt, HSO_3^-, and HNO_2^- are the necessary nucleii.

After the growing droplet — up to this point only growing if the relative humidity keeps increasing — reaches a certain size, any further increase in size results in decreasing the equilibrium pH. This situation obviously is a very unstable one, and so the droplets grow at a very rapid rate until so much water has been taken out of the vapor state that the R.H. drops to 100 per cent — usually when the droplets are between 10 and 50 microns in diameter.

However, we have only accounted by condensation for the formation of drops up to diameters of 50 microns or so — the cloud droplets. How is it that raindrops of diameters of 500–5,000 microns are formed from cloud droplets? One theory, developed by Langmuir, is that large drops grow at the expense of small drops because of the relatively greater ease of condensation on a larger drop. This theory, which has checked well with empirical data, explains the growth of drops up to a radius of only 100 or so microns, though.

United States Naval Air Service

The towering, thick, black clouds of the cumulonimbus *formation mean rain even to those who can't label them.*

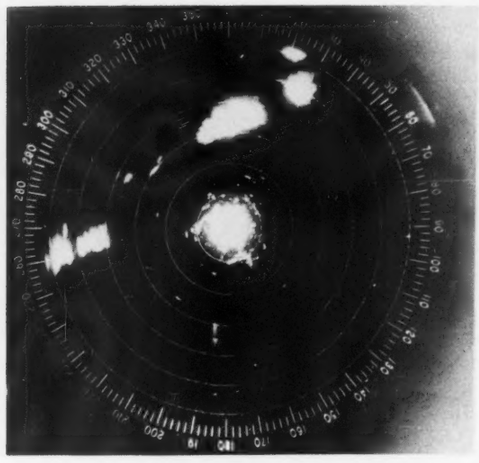
Another theory is that since the cloud drops are in motion relative to one another, growth is carried on by the simple process of coalescence. Calculations based on an assumption of a large drop-small drop mechanical collecting efficiency of about 50–90 per cent show that raindrop formation could be accounted for in this way. (The drop size in actual clouds does vary a great deal for unknown reasons.) However, it is still not known to what extent electrostatic or surface tension forces in operation between drops tend to impede their coalescence.

Still another theory (and this one by no means exhausts the plentiful stock), developed by Bergeron, is based on the experimental observation that below the freezing point, the vapor pressure over ice is less than that over water. Consequently an ice crystal in a supercooled cloud would grow very rapidly at the expense of supercooled water droplets and would eventually melt into sizeable drops of water in falling, or perhaps first turn into snowflakes which would in turn tend to coalesce with other ice crystals.

A combination of the above two theories may best explain the process: Ice crystals may grow rapidly into snowflakes as described above and then melt and coalesce with cloud drops. Since coalescence depends on the relative motion of drops, it is possible that a correlation may be found experimentally between the rate of precipitation and the audio-frequency fluctuations in radar return from the atom.

In actual RHI views of a cloud a bright layer is often detected at the height of the freezing isotherm; this layer may be partly caused by coalescence of wet snowflakes and subsequent melting. Above the bright layer the return is usually much less than below the layer, indicating that ice crystals are poorer reflectors than water droplets. Among other things to be determined are the limiting "visible" intensity of drizzle as seen on the scope and whether there is a discontinuity on the scope between actual precipitation regions and the region of mixed droplets and rain above. Of course the scope reader must always have enough experience to recognize distortions due to radar phenomena alone.

A primary objective of the project is not to work out theories, of which there is already an abundance, but to gather accurate, detailed data — a solid foundation on which to base theories and echo interpretation methods. This experimental task is not an easy one. Many complex instruments must be devised and a large amount of data obtained and properly correlated.



M.I.T. Weather Project

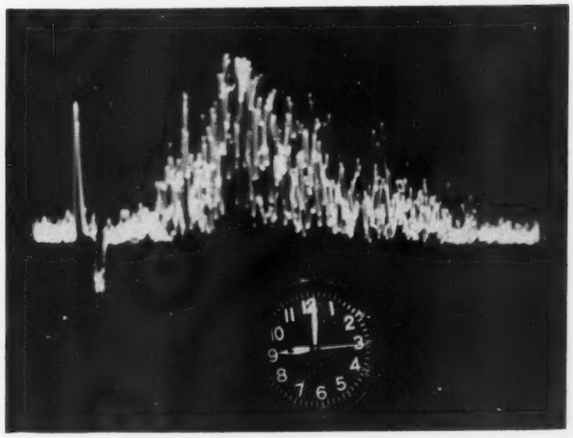
Bird's-eye view of a warm front approaching Boston, carrying rain clouds with it. The blur of light at the center is Boston itself and concentric circles are spaced at 20-mile intervals on the screen.

The radar sets are obviously the *sine qua non* of the investigation. The 615-B set is a very high power (750 kw. max.) 2800 Mc. ("S" band) radar set with very good resolution properties due to its small beam width, short pulse length, and high power. It has two 7-inch PPI scopes which give 30–60–120 mile ranges at will, and it contains a setup by which the center may be offset up to 120 miles, plus an "A" and an "R" scope.

(*Continued on page 30*)

An "R" scope magnification of an 8-mile segment of an "A" scope storm view. The sharply defined "pip" at left represents an airplane moving into the storm area, while the wide, jagged group of "pips" on the right indicates the storm itself.

M.I.T. Weather Project



A Look at Television Today

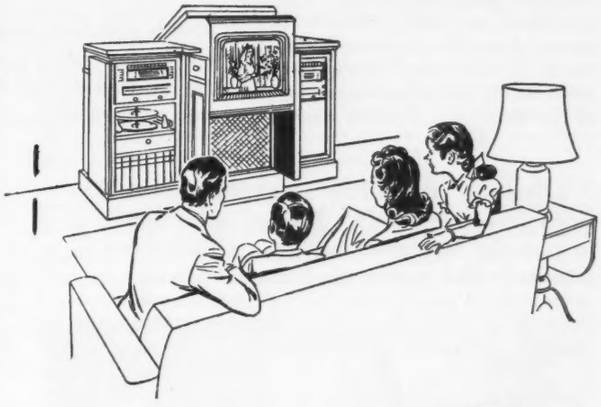
By JOHN W. WEIL, '48

"TELEVISION is *the* field of the future!" Almost every boy entering an engineering college about three years ago was bombarded with similar bits of advice. So too, was the layman as he read his copy of the Sunday paper and became convinced that television for the common man was just around the corner. With the end of the war, the buying public looked to the television industry for something really new and sensational.

But most people have been disappointed in their expectations about television, for the advertised wonders did not materialize in the quantity or at the price which was expected. On top of all that, objections to television and its use in the home became common, and the purchaser became more and more anxious to have his doubts and questions answered. In a recent interview with an executive of one of the largest firms in the television industry, frank answers to many of these questions came to light. The television situation is not as bad as many people would like to believe, although there are several major, non-technical difficulties of which every potential purchaser should be aware.

Television's main problems fall into three classes. Home operational difficulties and desirability probably constitute the most immediate source of trouble. Difficulties with purchase and installation make up the second heading, while the many details involved in production, programming and maintenance provide the third and final classification.

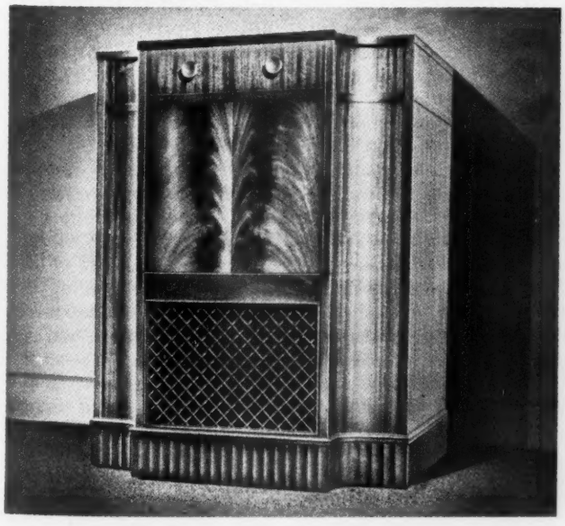
Just how desirable is television? It has been challenged on many counts along this line. To begin with, it must be looked at. This may seem silly, but to those who regard television as an improved form of radio it is a tremendous obstacle. In the home, a radio is often used as background for other forms of entertainment. True, while news programs and many comedy and dramatic shows are used as primary sources of entertainment, it is also probably true that the radio is most used to fill gaps in conversation during card games or to provide a restful background of music while reading or performing household chores. Television could not be so used, for, in order to derive the main pleasures from this new form of entertainment, it must be given complete attention, much as would a moving picture. For those who are merely looking for a bigger and better radio, television is not the answer.



Du Mont Laboratories

The family spends a pleasant evening at home watching television

This model has a direct-view screen with pictures 10¼ inches wide and includes FM and AM radio reception. *Du Mont Laboratories*



However, those persons who expect to find in television a new, primary source of entertainment are approaching the problem correctly. It is this sort of person who is most worried by the objections raised about television and whose decision to buy is thereby most affected.

One of the traditional difficulties with early television receivers was that the picture produced was not stable. The image jiggled and generally wandered around the tube, producing an acute sense of seasickness in the observer. Fortunately, this unsteadiness has been almost completely eliminated. Modern tubes and receivers give clear, stable pictures that tend to become unstable only when the receiver is so located as to be able to get only a very weak signal from the transmitter. In this case the "locking" of the incoming signals is somewhat vague and the picture wanders. But except for these few cases, the image produced can be comfortably viewed.

Early television sets were difficult to operate successfully. There was a profusion of knobs and dials covering the face of the cabinet, all of which served to make the average layman a mere novice at bringing in the pictures. This, of course, led to many objections about the kind of picture that television produced, while the only difficulty lay in the fact that the sets were too

difficult to operate. As could be expected, time has ironed out this problem to the extent that on the face of the modern receiver, besides the tuning and volume controls, there are only two knobs, one each for brightness and contrast. Thus, the modern set is no more difficult to operate than a radio which has a volume and bass-treble set of controls.

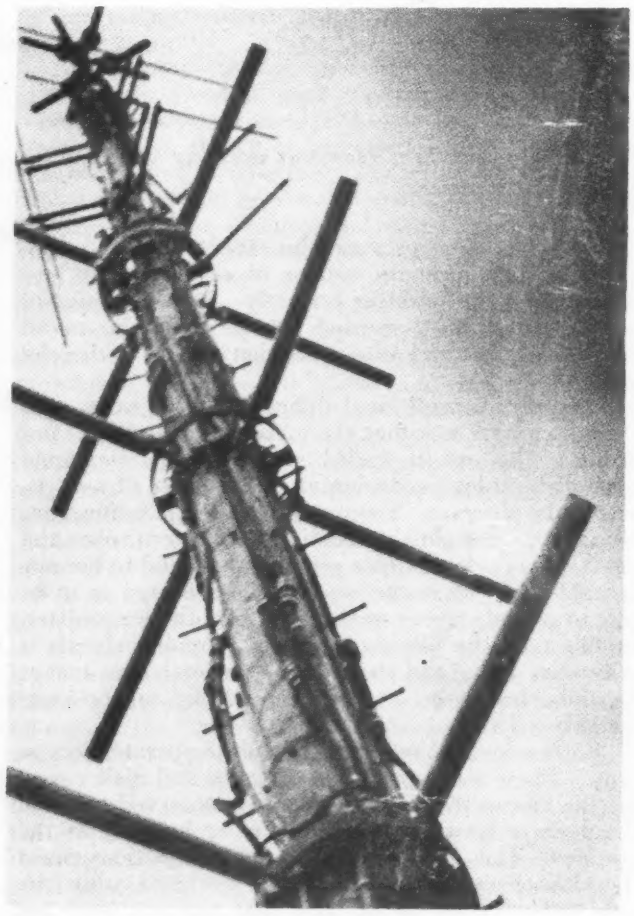
From the standpoint of purchasing and installation, the main objections to television have centered around the question of price. To begin with, television firms have been able to produce only a small number of sets in recent years, due to material shortages, with the result that they have tended to concentrate on the more expensive models. But more important is the fact that television is not and cannot be the common man's plaything. "Cheap" television sets will probably always run at about two hundred dollars because of the many intricate parts involved in the actual technical part of the receiver. Besides the expensive picture tube or video screen itself, a modern set contains thirty or forty tubes included in such necessary, but expensive, items as the video amplifier. Television sets are currently being manufactured and sold on a strict cost-plus basis in order to bring the models to the purchaser at the lowest price compatible with continued research and manufacture. But even so, prices are high and always will be high. Television sets will only be bought by those people who in the past would have purchased items in the price range of radio-phonograph consoles.

Radio Corporation of America

Mobile television unit. Soon, through a system of coaxial cables and microwave relay stations, the more densely populated sections of the United States will have front seats at any important event occurring within a reasonable distance of the television network.

A television transmitter antenna reaches skyward from New York's Empire State Building to give the Metropolitan area the latest entertainment and sports via invisible waves,

Radio Corporation of America



Having finally purchased a television set, the new owner will find that his one big problem involved in installation centers about the antenna. To begin with, as a general rule, each receiver must have its own antenna. This is not entirely true in that some exceptional installations located near to the transmitter have used as many as eight receivers on a single antenna, but such arrangements are exceptions rather than the rule. In private houses, this single antenna presents no problem due to the fact that only one receiver will probably be expected to operate in that house. In fact, within two or three miles of the transmitting antenna the problems of antenna set-up are so small that indoor antennas have been used successfully.

However, in apartment houses and closely-packed private houses the number of sets in use may require a prohibitive number of antennas. While this problem of multiple installation has not yet been completely solved, a partial solution has been found in the form of the Intra-video system and will be used in much of the new housing now under construction. This set-up is merely a large multiple antenna on the roof, with a good, interior, co-axial cable leading down the center of the building to be tapped by the various sets on different floors. So far this proposition has turned out to be extremely expensive, but the results have been good.

Once the installation of an antenna has been decided upon, its location becomes by far the most important consideration. The site chosen should be "in the clear"

and should be in direct line of sight of the transmitting antenna and as high as possible. Because of the directional characteristics of a television antenna, the antenna should be located so as to point at the largest number of transmitting antennas possible. Except in New York City, this problem is somewhat minimized by the fact that there promises to be a maximum of three transmitting stations in any given city, and the antenna can always be located so as to bring in at least two of these clearly. This problem, of course, is also minimized for the person living some distance outside of the city, since all the transmitting antennas will appear within a few degrees of each other when viewed from the receiving antenna. Only for receiving locations surrounded by transmitters in the heart of cities is this directional characteristic a real worry, and even then some workable compromise between the stations can usually be effected.

But the biggest single worry facing the man who wishes to install a television receiver is that of "ghosts." Television waves or signals will bounce off objects much as will light or radar impulses. Thus signals from a single transmitter can reach the receiving antenna by various paths, and while the time difference involved between the arrival of the various signals is small, it is sufficient to produce a second image on the video screen, displaced slightly horizontally from the first one. Such a secondary image is known as a ghost. In many cases these images can be neglected, but when a large building is located near the transmitter, a ghost of considerable intensity may be projected as a reflection of the transmission toward this building. Similarly, in choosing an antenna site for a receiver, a location away from taller buildings and other possible sources of ghosts must be decided upon. Unless this is done, a clear, well-defined image will be difficult to obtain.

Finally there is the problem that confronts most people intending to set up antennas, and that is that skilled specialists and considerable time are required to obtain a successful installation. While this is not always true, experience in setting up such antennas is a great advantage. Many retail television outlets now furnish installation crews to put up the antenna of any set purchased at their store.

From the point of view of producing, programming, and maintaining television as a business there are several problems of large proportion. Some of these problems arise from difficulty in carrying out the axiom that the receiver should be as simple as possible, while all complicated parts are located at the transmitter within the reach of competent, trained personnel.

In the past two years, the television industry has spent more money on development than has any other comparable industry. Profits have not been high, but because of advertising revenue derived from the companies who are willing to experiment with television commercials, a great deal of progress has been made in expanding the type of program beamed to the television audience. This expansion in programming will bring many more people into the television fold, causing

General Electric

A new television camera, light and flexible, takes short- and long-distance shots from the same position by quickly rotating the turret.

advertisers to take greater interest in such forms of advertisement, and so on. The beginning on this upward spiral has finally been passed — to the amazing extent that there are now over fifty thousand receiving sets in the New York area alone.

Programming has always been difficult because each program must go on with the precision of a finished play. This necessarily limits the number of dramatic shows which can be produced. But by the same token, television has an undeniable advantage in the presentation of news events, musical programs, and movies. Quite adequate coverage of the various fields of interest is now maintained by most all of the companies operating transmitters.

(*Continued on page 44*)

A large set features short wave, AM and FM reception as well as an 18-inch television screen and an automatic phonograph

Du Mont Laboratories

Infrared Telescope

By PETER JOHNSON, '48

DURING the recent war the armed forces were in great need of devices for seeing in the dark in such a manner that lights would not be exposed to enemy observation. Many of the highways of England were marked on the curbs with materials that fluoresced under ultraviolet light. Trucks and other vehicles having to travel the roads at night under total blackout conditions carried ultraviolet lamps mounted near the regular headlights, and the borders of the street became visible under the influence of the ultraviolet irradiation. There were many drawbacks to this method of seeing in the dark, especially that only objects coated with fluorescent substances could be seen directly under the ultraviolet light. The majority of substances absorb ultraviolet radiation so completely that even reflected ultraviolet rays are difficult to detect.

As a result, the efforts of United Nations scientists were directed toward developing a device that would operate on infrared rays, as invisible to the human eye as ultraviolet light. Since the rays of infrared light contain less energy than those of visible light, the infrared rays could not be converted directly into visible light, although several attempts have been made using substances that are "triggered" to release visible light under the influence of infrared radiation.

Radio Corporation of America

The portable sniperscope, a lightweight modification of the infrared telescope, was of great assistance to American troops during the Pacific campaign. Mounted on carbines carried by invading forces, it enabled them to sight targets in total darkness. The Japanese eventually learned the secret of the sniperscope, *but were never able to put it into quantity production.*

One of the least publicized instruments developed during the war to aid the United Nations forces was a remarkable night-vision instrument known as the *snooperscope* or *sniperscope*, using a novel combination of the photoelectric cell and cathode ray oscilloscope principles. Although the principles on which it operated had been known for several years, its practical utilization was delayed until nearly the end of the recent conflict. When it was finally perfected and used by United States troops in the Pacific, however, it was such a success that it was credited with being the cause of about thirty per cent of the Japanese casualties during the first few weeks of the campaign in which it was used.

The heart of the *snooperscope* was an infrared telescope that transformed infrared radiation into visible light. Commonly an infrared lamp, consisting of an ordinary tungsten-filament light with the visible radiation removed by very deep

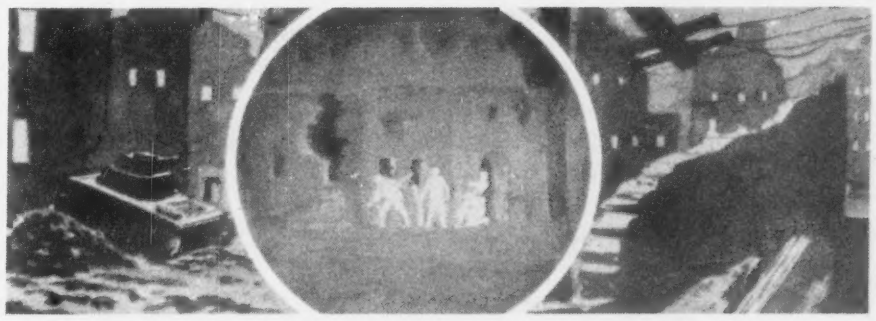
Radio Corporation of America

The carbine-mounted sniperscope *is shown here in detail. The infrared telescope, containing the RCA image tube, is mounted on top of the firearm, while the infrared lamp used to illuminate the field of view is fastened beneath. The instrument is powered by dry cell batteries contained in the satchel.*

red filters, was incorporated in the instrument, and the surroundings were illuminated by it with infrared light. The invisible infrared radiations were reflected into the infrared telescope, where they were converted into a visible image.

Inside the infrared telescope was a remarkable electron tube developed by the Radio Corporation of America, who produced the *snooperscope* in co-operation with the National Defense Research Committee. Measuring 4½ inches long by 1⅞ inches maximum diameter, it was a combination cathode-ray tube and photoelectric tube, evacuated to a high degree to permit electrons to travel freely through it. As the infrared radiation entered the telescope, it was focussed by lenses or a mirror system onto a translucent, photosensitive deposit of caesium oxide and metallic silver at one end of the electron tube. The rays of infrared light ejected negative electrons from the sensitive coating, and these were acclerated by a high positive voltage applied to electrodes inside the tube toward a fluorescent screen built into the opposite end of the tube. This screen, nearly the same as one in a television receiver or a cathode-ray oscilloscope, fluoresced under the bombardment of the electron stream, emitting a yellowish-green light.

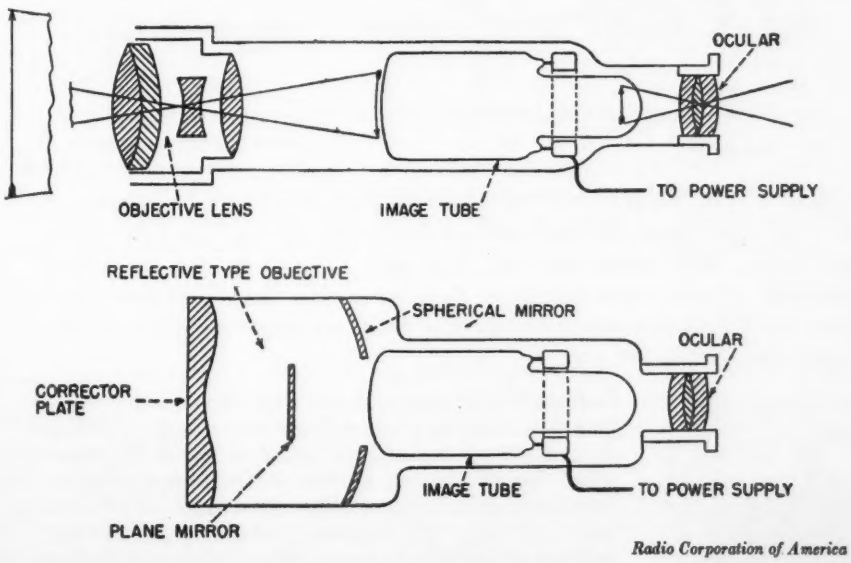
A street scene in a town as seen at night with the unaided eye



The same location as seen at night with the snooperscope

Radio Corporation of America

In order to reproduce on the phosphorescent screen the infrared image focused on the light-sensitive coating at the opposite end of the tube, the electrons emerging from the photoelectric surface had to be guided on their trip through the tube, so that electrons emitted by the same spot on the photo-sensitive layer would all be focussed at the same point on the fluorescent screen. To accomplish this end, the stream of electrons was made to pass inside a series of cylindrical electrodes charged with successively higher positive voltage. This so-called *electron lens* system focussed the electron stream on the screen to form an inverted reproduction of the infrared image at the other end of the tube. A telescope ocular then magnified the visible image on the screen, and increased its apparent distance so that the field of view through the telescope appeared natural to the operator.



Radio Corporation of America

Figure 1. Schematic diagrams of two infrared telescopes using the infrared image tube. The refractive system at top is useful for short range; the reflective type is more suitable for long range.

Figure 1 is a schematic diagram of the infrared telescope, including the objective focussing system at the front of the telescope and the magnifying ocular on the other side of the electron tube.

Figure 2 is a more detailed drawing of the internal construction of the image tube, showing the photosensitive cathode, or negative electrode, and the complex electron lens system used to focus the electron beam emerging from it on the fluorescent screen. The cylindrical electrodes G_3 and G_4 are the principal elements of the electron lens system. The auxiliary cylindrical electrodes G_1 and G_2 through which the electron beam passes correct for curved distortion of straight lines in the image produced by the electron tube, commonly known as "pincushion effect" in optics, since a rectangular picture is distorted into a pincushion shape. To further reduce distortion the photosensitive surface is curved to match the curvature of the image field of the objective lens or mirror system used to focus the infrared light on the tube's photosensitive surface.

One of the major problems connected with the design of the instrument was discovering the proper materials for forming the photosensitive film and the fluorescent

Radio Corporation of America

The 1P25 infrared image tube, designed by the Radio Corporation of America. It is the heart of the infrared telescope. Combining a photoelectric cell and a cathode ray tube in one envelope, the 1P25 tube converts infrared radiation into visible light by electronic means.

electrons inward from its inner surface. Since the vapors of caesium are very active chemically, the material for the fluorescent screen also had to be chosen with care. Synthetic willemite was finally selected as the fluorescent material, since willemite is very sensitive in its response to the impact of electrons and is stable in the presence of caesium. Unfortunately, the time constant for the decay of the image on the fluorescent screen is not very small — about .04 second for a decay to one-tenth its full intensity. As a result, rapidly moving objects appear somewhat blurred. Outside of this factor, however, the definition of the image seen through the infrared telescope is very good, limited principally by the human eye itself.

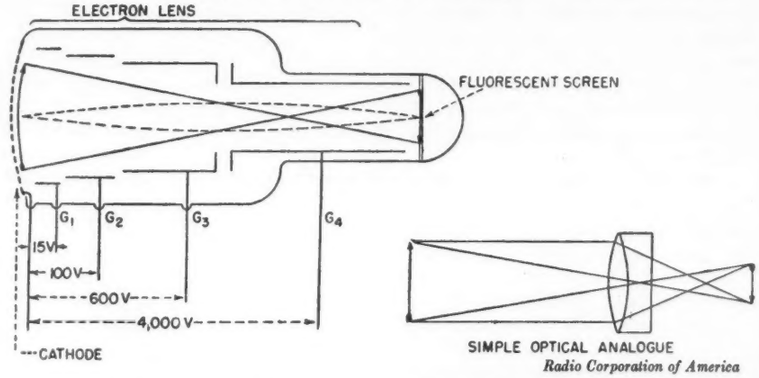
The sensitivity of the infrared image tube is approximately one, meaning that for every lumen of infrared light that falls on the photoelectric coating a lumen of visible light appears on the fluorescent screen. As a result of the high conversion efficiency of the image tube, objects viewed through the telescope under infrared light appear approximately one-tenth as bright as when seen by visible light of the same intensity.

The power requirement for accelerating the electrons from the photosensitive cathode to the fluorescent screen is only .1 watt. As a result, dry-cell batteries are used as the source of power for the instrument, and the entire instrument is portable. The current from two dry cells in series goes through a vibrator and transformer, which converts the low direct-current voltage to a very high alternating current voltage (5,000 volts). A specially designed high-vacuum rectifying tube converts the alternating current voltage into a direct current one which operates the electrodes of the infrared tube. During the war the power supply presented a special problem in noise silencing, since the instrument was often used under conditions in which secrecy was absolutely essential. One such use was the invasion of many of the Japanese-held islands in the Pacific. An especially light weight form of the *snooperscope* was mounted on the carbines of the invading troops, and an infrared light was attached to the lower side of their guns. This instrument, nicknamed the *sniperscope*, was of inestimable aid in allowing the troops to sight and fire at targets in the total absence of light.

During the war, many other modifications of the *snooperscope* were utilized for a variety of applications.

(*Continued on page 48*)

screen. The rays of infrared light do not possess sufficient energy to activate most photoelectric substances, but a complex mixture of silver, caesium, and caesium oxide was discovered to be sensitive to infrared radiation. Since caesium is an extremely active alkali metal, it loses its electrons with ease, and thus was suitable for the infrared image tube. The material had to be deposited on the inside of the tube in the form of a very thin translucent coating, so that the infrared light could penetrate it and release



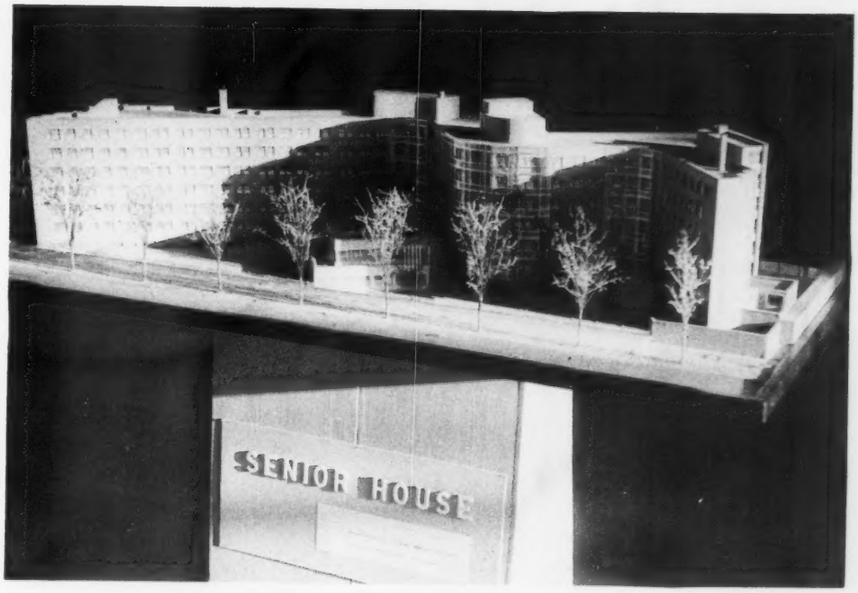
Radio Corporation of America

Figure 2. A diagram of the interior of the 1P25 tube, showing the arrangement of the electrodes in the image tube and the potentials required. The electrodes G_1, G_2, and G_3, form the principal elements of the electron lens system, while the high-potential electrode G_4 accelerates the electrons from the photosensitive anode to the fluorescent screen.

The Navy's special modification of the snooperscope, designed for long range signalling at night by infrared rays. The instrument is effective in the dark over a range of many miles.

Radio Corporation of America

Tech Expands Its Living Facilities



Peter M. Lang, '51

New Senior Dormitory Will Feature Modern Design

ON Monday, October 13, ground was broken for the new Senior Dormitory at M.I.T., which will probably be completed in time for occupancy during the fall of 1948. It is hoped that the student housing problem, which has been very difficult for the past two years, will be alleviated by this new addition.

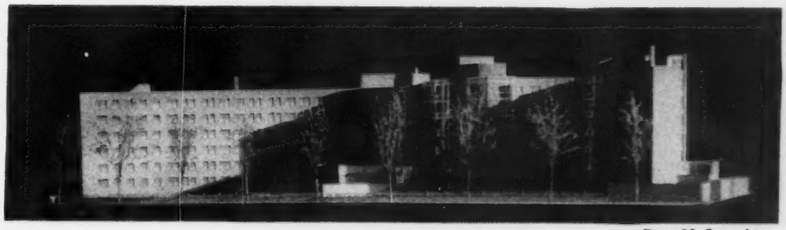
The design of this building was perfected by the Finnish architect, Alvar Aalto, research professor of architecture in the Institute's School of Architecture and Planning. The dormitory will be six stories in height and will house three hundred and fifty-three students in one-, two-, and three-man suites. However, the majority of occupants will be in single rooms. The furniture will be all built in, except for the chair, and will include a desk, bookcase, couch, wardrobe, lavatory, and bed. Each item will be of light, blond, hardwood to contrast with the red tile walls. Acoustic ceilings and asphalt floors will be included in these modern appointments.

The double rooms will be similar to those occupied by one man, except for necessary additional facilities. However, the triple suites will provide a living room area in addition to a sleeping room. Additional space will be provided for those who wish to carry on discussions and engage in recreation without disturbing study in the individual rooms.

Other rooms in the building will include a lounge, dining room, music room, living room, and hobby room on the first floor. Here the dining room balcony and dormitory office will also be found. The former will be an extension of the main lounge and overlook the main eating area. The dining facilities will be supplemented by the latest in kitchen equipment.

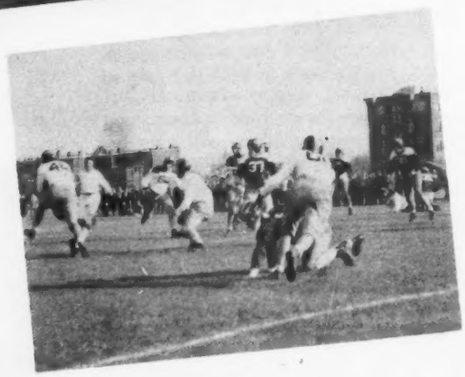
One of the most unusual aspects of the architecture will be the building's shape, permitting the sleeping rooms to have a maximum southern exposure. In order to achieve this a combination zigzag and serpentine design has been adopted.

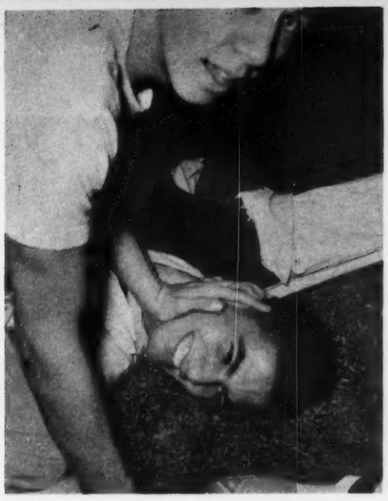
The dormitory will be located on Memorial Drive in Cambridge, a few hundred yards west of the main buildings of the Institute. While the front of the house will overlook the Charles River, the rear will face the M.I.T. athletic fields. The outside will be of red brick to match the similar construction of the present buildings along Memorial Drive.



Peter M. Lang, '51

Tech Has A Field Day



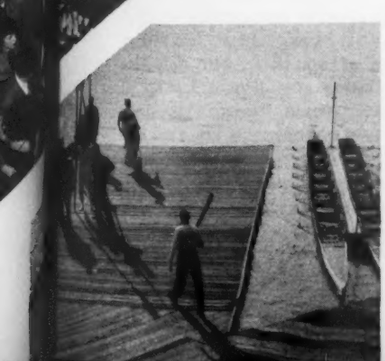


Classes recessed at 12:00 on Saturday, November 1, as Techmen poured out onto Briggs Field for the annual Field Day. It was Freshman against Sophomore, with practically no holds barred, and many were the faces that were spattered with dirt after it was all over.

The rivalry that preceded the actual day of combat was one of the bitterest on record; dummies were strung up between Walker Memorial and the Dorms; butyric acid, a chemical with a very powerful and penetrating odor, was sprinkled liberally in the Barracks and in Huntington Hall, where the class rallies were held. Water fights and cars equipped with loudspeakers added to the confusion.

The afternoon was filled with tennis, swimming, football, tug-of-war, crew, track, and, of course, the glove fight. The fight was bitter and serious, but the Sophomores, with their extra year of Tech indoctrination, thought that they would win by brains where they lacked brawn and so took many gloves off the field. The Freshmen, nevertheless, carried the fight and the day.

Although few of the participants had enough energy for strenuous activity, most everybody had a good time at the Field Day Dance which put a very pleasant cap on a very exciting day.



Water, Water Everywhere

By CHARLES A. LICHT, '48

THE problem of water supply is one which has bothered mankind throughout creation. From earliest history water, pure, fresh and potable, has been difficult to locate, and supplying it to the growing civilizations of the world soon presented the greatest of the problems of survival to urban mankind.

The Romans, at one time rulers of the known world, spent many millions of man-hours constructing their famous roads which tied together the great empire, in order to maintain the supplies of materials for food and shelter for the home city's many thousands, but these roads were not nearly as symbolic as the remains of the Roman aqueducts, some of which are still in use. These aqueducts were, indeed, man's first effective attempt to live away from an adequate water supply.

The commerce and civilization of the advancing world cultures always followed the rivers and centered around the wells and water supplies of the world. Even ships were forced to remain close by land so that their tiny fresh water supply could be periodically replenished. It was for this reason that so few ships ever attempted the westward journey from Europe.

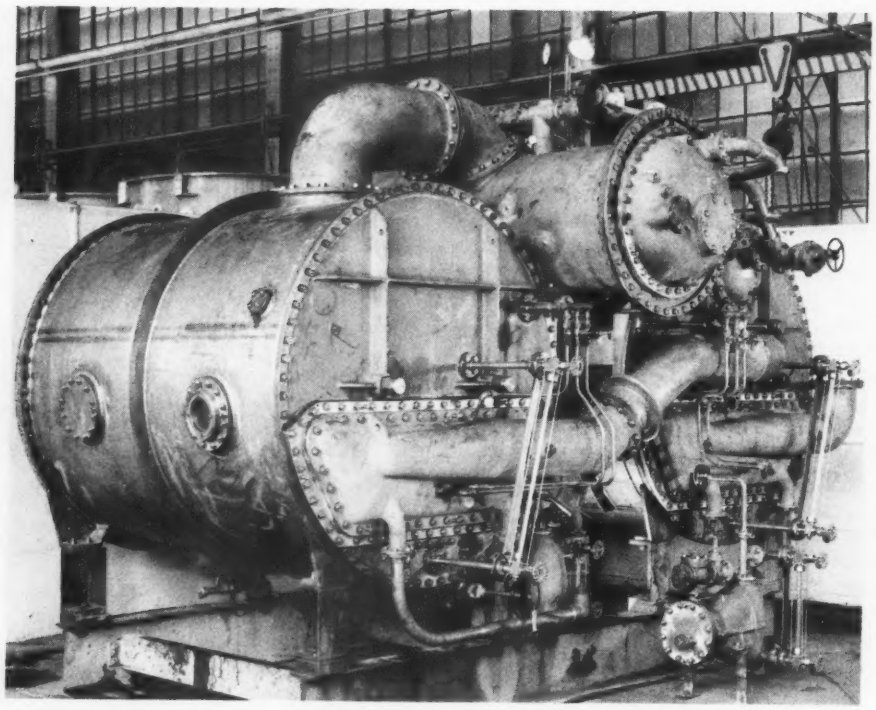
The problem of water supply was more or less easily solved as long as there was the possibility of a direct line between the source and the ultimate user. But what was to be done when a ship was several hundred or thousand miles from the nearest sweet water supply? That was the question which faced the shipbuilder and traveler. The easiest approach was to build vast water storage tanks into the ship, but this cut the available cargo space and was only practical when no other method was available.

As time went on and the use of steam came into its own aboard ships, the use of distilling equipment came into wide use. This equipment had the advantage of being compact, and relatively light in comparison to the weight of the water tanks used before.

The U.S.S. Missouri *at sea* — *United States Navy*

As the demand for more powerful steam generators increased, the demand for high steam pressures in the boilers and higher rates of boiling soon made it evident that the relatively high salinity "shore water" used in the boilers was too full of impurities to allow for maximum boiler efficiency for more than a short time, since these impurities formed on the boiler tube surfaces and cut down the rate of heat transfer. With the advent of the "express" boiler and the modern naval boilers of the water tube variety this objection became so great as to cause a revision of the acceptable salinity content of the boiler water. Even shore water was not good enough for the boiler feed; distilled water became a necessity.

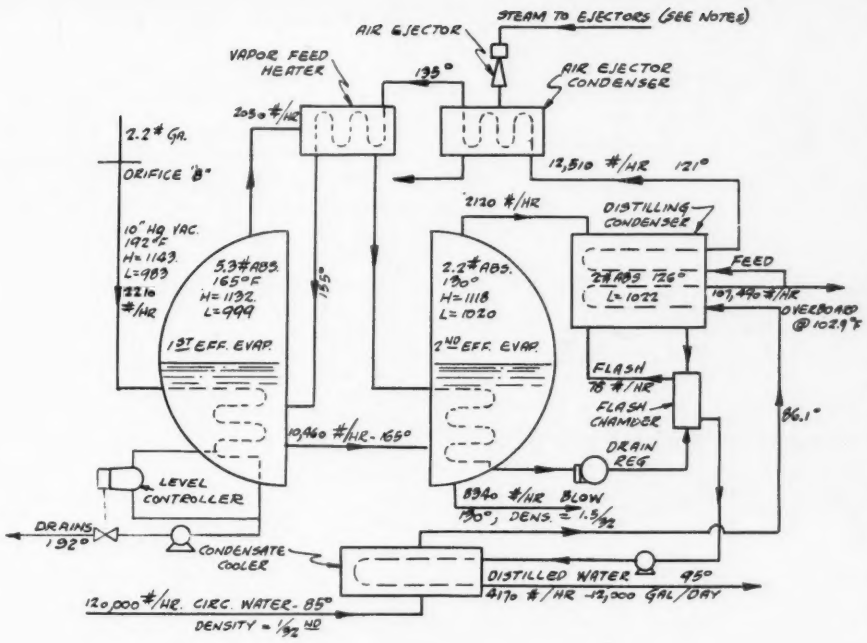
Figure 1. Front view of a Griscom-Russell vacuum distillation unit. Capacity 20,000 gallons per day.



In order to obtain this distilled water, evaporators were installed on all ocean going vessels, thus enabling the ship to supply its own boiler feed and drinking water without being dependent upon any shore bases.

An evaporator is essentially nothing more than a big kettle with a condensing coil attached to the spout. Of course, since the production of water is an expense, the maximum efficiency must be maintained, and to this end many types of evaporators have been designed and put into use.

The most fundamental basis on



Heat balance diagram of 12,000 G.P.D. distilling plant operating under normal load.

which evaporators may be classified is that relating to the disposition of the steam and water within the apparatus. On this basis the three recognized types are the (1) steam tube type, in which the water to be vaporized surrounds the tubes containing steam, (2) the water tube type, in which the opposite arrangement exists, and (3) the flash type, in which preheated water vaporizes upon being injected into a chamber wherein the pressure is maintained at a pressure less than the saturation pressure at the temperature of the water. There can be further classification; an evaporator of the *pressure type* is one in which steam is supplied to the apparatus at a pressure above atmospheric, while the *vacuum type* receives its steam at a pressure below atmospheric.

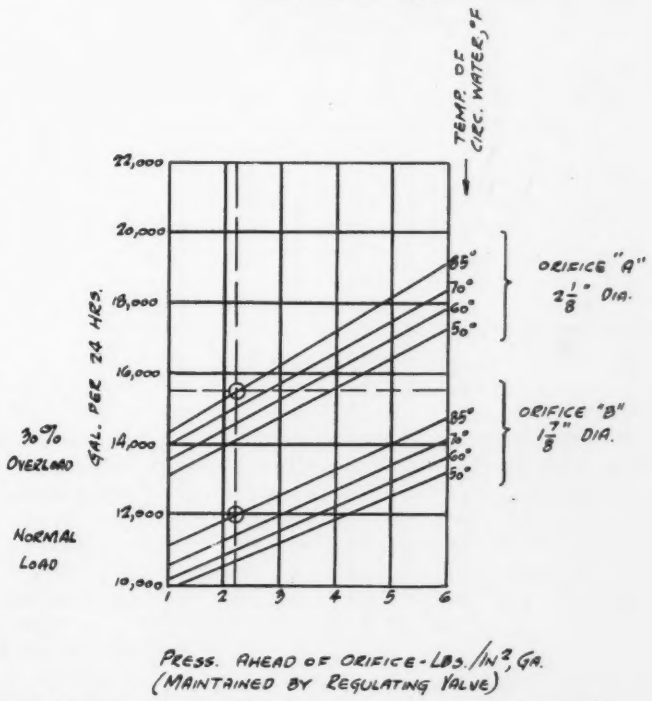
Up to about 1920 the type of distilling plant in general use throughout the United States Navy was the high pressure steam tube type, in which the steam was taken directly from the boilers and reduced to various working pressures up to as high as one hundred and fifty psi. Great troubles were experienced in the evaporators of these plants with the formation of scale upon the tube surfaces, and it became necessary to raise the steam pressure day by day until, to get the capacity of the plant, the limiting pressure of the coil was reached. At this point the plant had to be shut down, the coils pulled out and the scale removed from the tube surfaces. This scale was very difficult to remove, so that this operation often caused damage to the tubes as well as being a very tedious process.

In 1920 the Navy installed vacuum steam tube distilling plants on all new construction. These plants were so called because the primary effects operate under a low pressure and the later effects under progressively lower pressures. This plant is today in general use throughout the American Navy. In it the primary heating agent, instead of being high pressure steam from the boilers, is auxiliary exhaust steam which has already given up a large share of its enthalpy in the work it has done in the various auxiliaries, such as the pumps, anchor engines, etc. If this steam were sent directly to the condenser the heat content would be lost. By sending it to the evaporators fresh water is obtained by the exploitation of the heat units which were lost in the older high pressure systems. The advantages of the vacuum type system are:

1. No demand is made upon the boiler for high pressure steam.

2. The low pressures and temperatures characteristic of this plant prevent the precipitation of various solids in the sea water. In this connection, it might be noted that the most harmful of these is the sulphate deposit which precipitates at about 245° F., a temperature not usually attained in a well operated vacuum distilling plant. Below 245° F. only carbonate scale is formed on the tube surfaces and even this amount decreases rapidly with decreases in the temperature.

3. The fittings, flanges, and other structural parts are less expensive and easier to make and maintain in order.

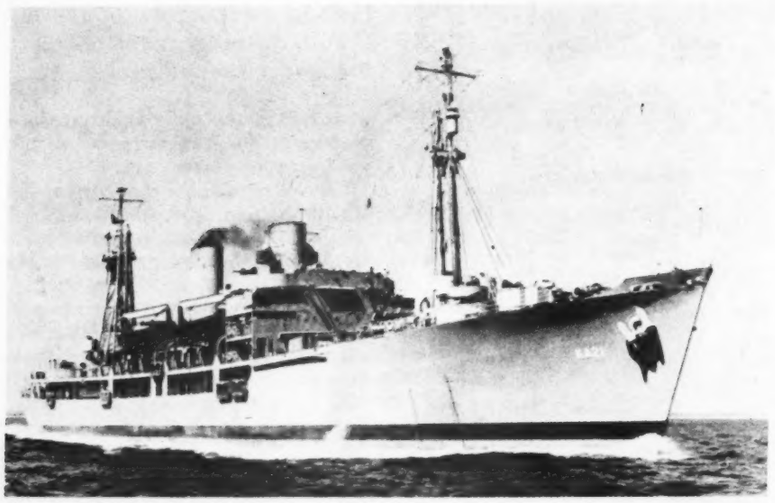


Orifice control diagram, showing estimated capacity as a function of the pressure ahead of the orifice.

4. The temperature range permits the plant to be designed for triple or quadruple effect operation, with resulting greater efficiencies, whereas high pressure plants are seldom designed for more than double effect operation.

5. The over-all cost of maintenance and operation is decidedly less expensive.

One type of low pressure vacuum distilling plant is shown in Figure 1. This type is a double effect plant with the shell of the evaporator divided by an air-tight partition. The left hand half of the shell is the first effect while the right hand side is the second effect. This type was installed on many of the smaller Navy



A cargo transport *Westinghouse*

ships; it has a capacity of twelve thousand gallons per day. The twin shell type, of about the same capacity, was also used on types of ships up to CVE's. The "soloshell" type evaporators were more efficient because there was less surface area for heat loss.

Steam System

In the Griscom-Russell "Soloshell" evaporator the auxiliary exhaust steam for the operation of the plant is introduced into the coil of the first effect evaporator, after being desuperheated by the introduction of distilled water into the line. The steam pressure is further reduced prior to entering the tube nest by having it expand through an orifice plate. When the steam reaches the tube nest it begins to give up heat to the salt water surrounding the tubes, and condenses. The condensate is quite hot, nearly at the temperature of the entering steam (normally about 240° F.). The heat of this condensate would be lost if it were returned directly to the condensers and would overheat the feed tanks if led directly to them. To remove all possible enthalpy from the condensate it is run through the coil drain feed heater, through which the salt water feed for the evaporators is passed. In order to use a feed heater with this condensate and also to prevent steam from blowing through the coil before it has given up its latent heat, a trap, called the tube nest drain regulator, is put into the line to the condenser beyond the feed heater. This regulator maintains a water seal on the first effect tube nest by means of a ball float mechanism. From the tube nest drain regulator the condensate returns to the feed water tanks, either directly or through the condensers, and is used over again in the boilers.

Vapor and Fresh Water System

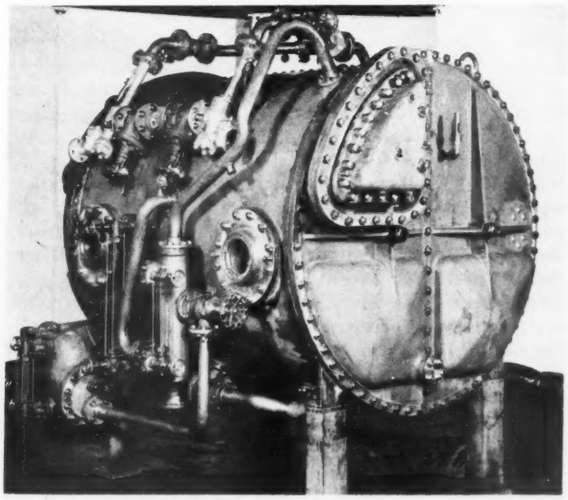
The vapor which is formed in the first effect shell then passes over a set of baffles and vapor separators which remove any carried-over salt droplets and permit the vapor to pass on to the vapor feed water heater, where part of the vapor is condensed. The condensate and remaining vapor pass together into the second effect tube nest where the vapor is condensed, thus giving up its latent heat to the brine. This condensate also passes through a tube nest drain regulator and then on to the distilling condenser. The fresh water from the distiller then goes to the condensate cooler. This reduces the tendency of the condensate to flash when being pumped to the reserve feed water bottoms and the ship's drinking water tanks.

Salt Water System

Circulating water for the distiller is taken from the sea by the distiller condenser circulating pump, sent to the distiller, and discharged overboard. Inside of the overboard discharge, connection is made to the discharge line from the distiller, and through this line salt water at higher than sea water temperature is obtained for evaporator feed. A regulating valve is fitted so that the temperature can be kept as high as possible.

From the distiller the feed is taken by the evaporator feed pump. On its way to the first effect shell the feed water passes through the second effect vapor-feed heater, then through the first effect vapor-feed heater, and finally the first effect coil drain feed heater.

Another view of a complete distilling unit for use on ships

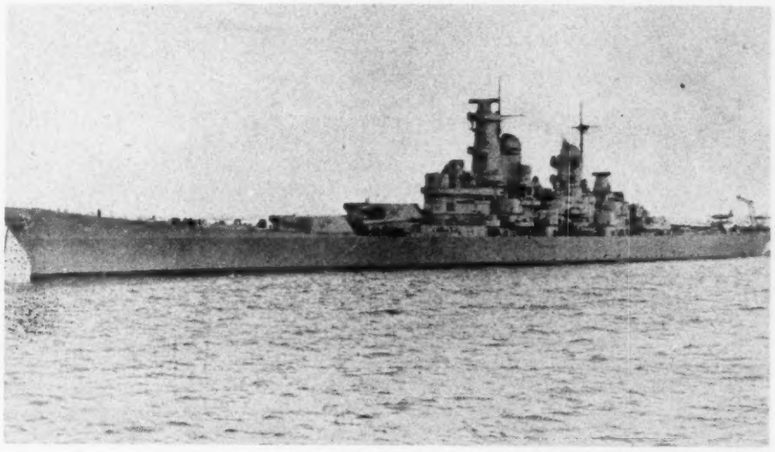


At first glance it would seem that use of vapor feed-water heaters would be a case of lifting oneself by one's bootstraps. The gain obtained comes through the heating of the water in the first effect shell to a higher temperature and thus lowering the vapor temperatures in the other effect. By these two results a better distribution of heat transfer throughout the evaporator results. (As an example: with steam feed to the first effect tube nest at pressure of 25 psia and saturation temperature, and feed at 60° F, for every pound of steam supplied the first effect produces 0.855 pounds of vapor at a pressure of 9.5 psia and a temperature of 190.8° F. This vapor is then run through the tube nest of the second effect where 0.768 pounds of vapor at a pressure of 3.0 psia and temperature of 140.1° F are produced; thus, with the double effects 1.623 pounds of water are obtained per pound of steam supplied. Under ideal conditions

Single effect produces 0.87 lbs. water/lb. steam.
Double effect produces 1.623 lbs. water/lb. steam.
Triple effect produces 2.275 lbs. water/lb. steam.

Air Venting System

Air entrained in the auxiliary exhaust would be trapped in the first effect coil by the water seal maintained by the tube nest drain regulator. Similarly, air entrained in the salt water feed would be trapped in the coil of the second effect. Thus, if no system were provided by which to vent the air, the pressure would eventually build up in the coils and shells and the plant would become air bound. To alleviate this condition steam-jet air ejectors, which draw out the air from the shell, are employed. The air vapor and steam mixture is then run to an air ejector condenser where the steam and vapor are condensed and the air vented to the atmosphere.



Official United States Navy Photograph

The U.S.S. Iowa *as she appeared fresh from the builder's hands*

Salinity Indicators

In order to know continuously the suitability of the water being produced, electrolytic salinity indicators are fitted on the fresh water line and on the brine discharge line which give instantaneous readings of the salinity of the fresh water or the brine. Connections are made from the salinity indicators to automatic signal lights. In the case of the standard Navy fresh water indicator the usual setting for the various numbers of grains of chlorine per gallon of water are as follows:

White (good for boiler feed) 0.0–0.3
Green (drinking, *not* boilers) 0.3–5.0
Red (unfit for use) Over 5.0
(For comparison, San Francisco city drinking water tests an average value of about 5–6 grains per gallon.)

From a thermal standpoint evaporators give very good performance because nearly all the energy supplied in the steam (except for radiation and conduction losses to the atmosphere, and the hot water lost in "blowdowns") appears in the vapor produced or in the condensate. It is for this reason that the vapor and condensate are handled with such care so that maximum heat transfer can occur. The vapor is occasionally condensed by the feed water on the way to the boiler, so that the latent heat of vaporization may be returned to the boiler, and this condensate is put back into the feedwater system at a suitable point depending on its temperature.

The evaporator itself can be arranged so that it can be effectively used to produce *process steam* at a pressure lower than that maintained in the boilers. This was a system made use of by the Navy prior to 1920, but has not been seen on Naval ships since then. For use on land installations this is a process which is employed to a large extent.

The operation of the low-pressure vacuum distilling plants is one which requires a minimum of training or even understanding. On many Navy ships the introduction given a fireman was a set of eight or ten rules to follow and a sketch of the plant arrangement. The whole secret of maximum water production with the designs now in use is the establishment of steady state conditions. Once steady state is established the evaporator is capable of maintaining as much as 150 per cent of rated capacity in calm seas. During unsettled weather conditions the rolling and pitching of the vessel tends to allow the carry-over of salt water, thus making it necessary to carry lower water levels in the shells and thereby lowering the rate of water production.

The problem of elimination of scale formation over long periods of time is one which as yet has not been solved. The scales formed at the temperatures found in the low pressure vacuum evaporators are the soft carbonates, which are easily removed once the tube nest is taken from the shell. However the problem of scale removal without having to shut down the plant for periods ranging from twelve hours to several days is still the bogie of the evaporator designer and operator. During the past war, many systems were attempted, both with the official sanction of the Bureau of Ships of the United States Navy and also without this sanction. The use of "shock" treatments, the use of starch compounds, the use of chemi-

(*Continued on page 50*)

An American freighter arrives in Japan

Official United States Navy Photograph

Official United States Navy Photograph

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Can You Do It?

THE ELEVENTH IN A SERIES OF MONTHLY BRAINBUSTERS

THIS MONTH: A simple problem in home economics . . .

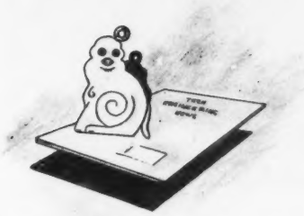
Problem 1: Suppose you are given a toaster and three slices of bread. The toaster is of the old-fashioned variety that can toast only one side of the slice of bread at a time, but can handle two slices of bread at once. Now it turns out that it takes .50 minutes to toast each side of a slice of bread, .05 minutes to either place a slice of bread in the toaster or remove it from the toaster, and .02 minutes to turn over a slice of bread in the toaster. The rules of the game are merely that the toast cannot be under-done or over-done and that you can handle only one slice of bread at a time. What is the shortest time in which you can toast the three slices of bread? The answer is 1.77 minutes, but can you get it?

Problem 2: If you found the last one easy, try this one. Under the same conditions how many pieces of bread could be toasted by one operator in 1.77 minutes if he had all the toasters he needed? How many toasters does he need?

J. W. W.

(*Answers given next month*)

The Dragon's Den



The Almighty State . . .

In the July-August issue of *Ordnance*, "The Magazine of Scientific and Industrial Preparedness," is a picture of a handsome lad pouring the contents of a test tube into a large flask. The photograph is captioned: Science for Security.

Now that science has proved its worth in devising more efficient weapons of battle, government and business leaders are proclaiming science as a necessary tool of "preparedness."

The search for knowledge, science, is to be subordinated to the search for power, government. It may be pointed out that nationalism, the basic cause underlying the fear of other nations, is only a few hundred years old. Science is not international; it is supernational.

An acquaintance of ours remarked that his technical training here at Tech would allow him to be of great use to the government. The same friend rubs his hands gleefully whenever an ingenious new method for destruction of mankind is announced. He means no real harm, but he is, nevertheless, typical of the unthinking "patriots" of our day. The human being is important, not the government, which many philosophers believe exists for the benefit of the people. We do, too.

The point being that, whether you think so or not, Tech engineers are really scientists. And, therefore, as scientists, do you want to serve the government or society, keeping in mind that your personal welfare is inextricably bound up with society's?

THE NOT-SO-ALMIGHTY STATE

After all the talk about "isms," how wicked they are, and how they must never be allowed to arise again, we must look like perfect fools to the rest of the world. We have recently perfected a new "ism," one which promises to be just as deadly as any one of its predecessors or contemporaries. And that is, "Americanism." For instance, the American Legion, always in the forefront of progress, has an Americanism director, who fills a post in existence since 1936. If memory serves me correctly, this was the year that college students became ardent members of military-type organizations, and the year that the poor people were re-electing Roosevelt. The ism, used with a lower case "a" for a long time, has now assumed new and glowing importance by the simple substitution of a capital "A" for the small one. Accordingly, official approval has grown right along with the size of the first letter.

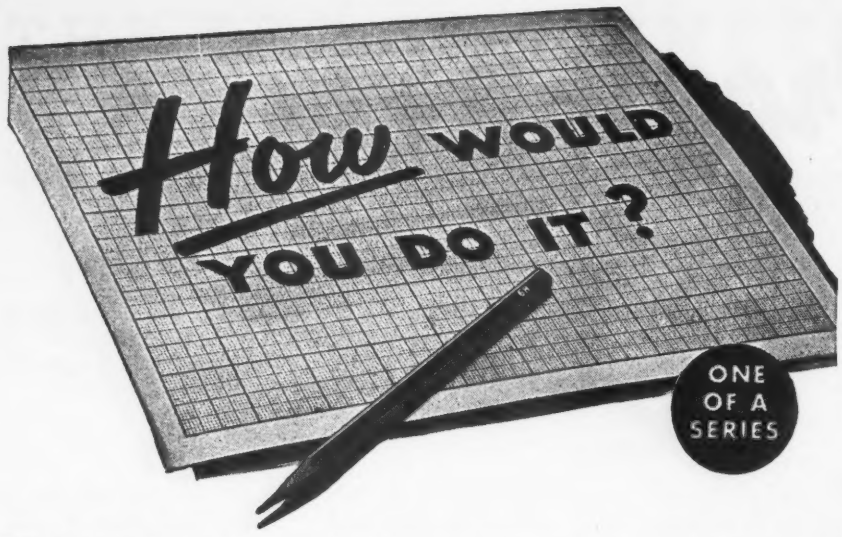
The American Legion purports to identify itself with the interests of the United States people and government. Since they constitute a very vociferous and numerous minority, we may assume that their influence is not negligible, even where there are honest elections. It is also the contention of the Legion that the organization itself is the best judge of the loyalty of its members. Since the Legion has identified itself with the government, you are led inescapably to the inference that whatever the Legion disapproves of will also be disapproved of by the government. This would not be so serious if the Legion's views really represented the opinions of the majority of its members. It does not, and the fact that it does not is becoming increasingly evident from convention reports. For example, the name of the *new* national commander was reported in a New York newspaper *two* days before the convention opened in that city.

The government, not-so-perfect, is conducting what must inevitably be an overbearing and imperfect "loyalty" check. By the way, the American Legion is carrying on its own loyalty certification. Shall the twain meet?

PHILOSOPHY

"Hard work will probably bring you no business success unless it is seen by the boss," said Philip Reed, chairman of the board of the General Electric Company. "Notice" is known by a much more affectionate term to most students, and few students believe that they achieve "notice" without losing integrity. Thus, Mr. Reed has merely pointed out what many people have realized for a long time; prejudiced personal contacts are more determinant of ability than the ability itself. All of which makes us wonder at the callous hypocrisy that represents "maturity" in man, who is supposedly far above the animals.

E. M. K.



PROBLEM — You are designing a circular saw. The blade must have horizontal, vertical, and angular adjustments. Your problem is to work out a drive for the blade that permits this three-way adjustment. How would you do it?

THE SIMPLE ANSWER — Use an S. S. White flexible shaft to bring power from the counter-shaft or motor to the blade. There is no simpler mechanical means than a flexible shaft for driving parts which must be adjustable. And simplicity in design means economy in production.

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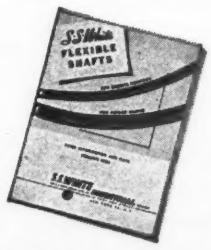
This is just one of hundreds of remote control and power drive problems to which S. S. White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these tireless "Metal Muscles" for mechanical bodies.

Photo courtesy of Flexsaw Mfg. Co. Port Austin, Michigan

Here's one prominent manufacturer's solution to this problem.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. Write for your free copy.



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AN EYE FOR WEATHER

(*Continued from page 12*)

The AN/TPS-10A set is a medium power (65 kw. max.) 9090 Mc. ("X" band) set which scans a vertical cross section along a given azimuth with its very narrow beam, using an RHI scope with a 60-mile range and 35,000 feet max. altitude. If we neglect atmospheric attenuation, the signal return from a storm on the 3 cm. TPS-10A should be twice that on the 10 cm. 615-B. However, 10 cm. radiations are less attenuated by atmospheric water vapor than 3 cm. radiations.

H. T. Floreen

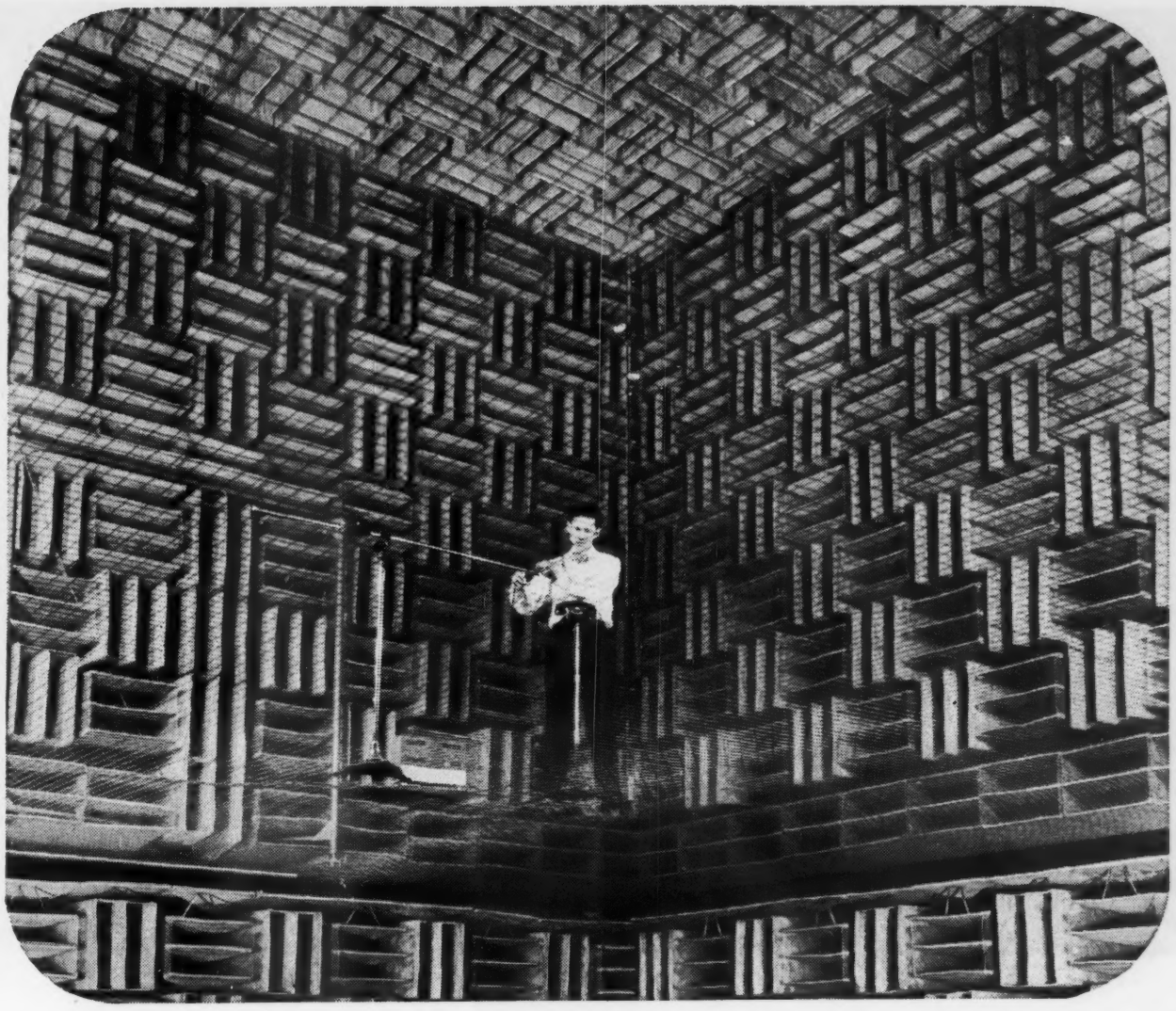
The sun brightly illuminates these "islands of the sky" which appear in fair weather and are named cumulus.

The echoes received from precipitation areas, which are the primary subject of investigation by the project, fluctuate so rapidly that a pulse integrator device is needed to obtain a measure of the average intensity. Since these echoes occur only once every 2500 micro-seconds on the 615-B, a special device developed at the Radiation Lab must be used in place of any conventional d.c. meter. Signal strength will eventually be measured at several different audio-frequencies to plot the audio-frequency spectrum of a returned signal from a storm.

Photographic records are kept of the PPI scope views of all storms studied. When more material has been obtained, analysis may reveal a useful relationship between the elliptical cell appearance and other structural appearances of a storm and their characteristics.

The next most useful piece of

(*Continued on page 34*)



SHHHHHHHHHH!

Quiet.

Walk into this new acoustic test room at Bell Telephone Laboratories and all you'll hear is silence.

It's about the quietest place on earth.

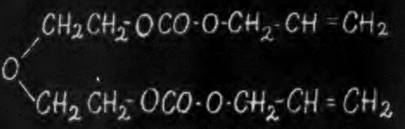
This non-reverberant chamber was ingeniously designed by telephone engineers so that acoustic development and research could be carried on under the best possible conditions. It's another aid in a continuing program to improve communications.

This is telephone engineering at work.

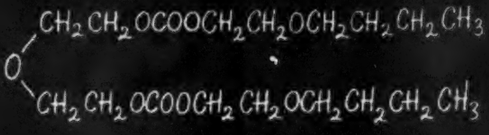
BELL TELEPHONE SYSTEM

Continuing its study of the chemistry of Phosgene, Columbia's Technical Staff has developed such products as:

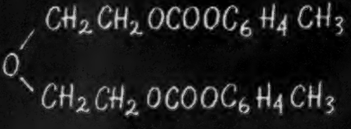
ALLYL DIGLYCOL CARBONATE



BUTOXYETHYL DIGLYCOL CARBONATE



CRESYL DIGLYCOL CARBONATE



These are important derivatives of Columbia's Diglycol Chloroformate. The first, Allyl Diglycol Carbonate, is an exceptionally versatile liquid organic ester which is readily converted into a thermosetting plastic when heated with polymerization catalysts, such as peroxides. Under its trade name, "Allymer CR-39," it had numerous valuable aircraft applications during the war.

"Butoxyethyl" and "Cresyl" are organic ether-esters of low volatility which are soluble in a wide range of solvents and compatible with many resins and plastics. They are being used to advantage as plasticizers and have excellent potentials in other applications such as high boiling solvents, pharmaceutical and lubricant compositions.

The introduction of specialties such as these requires the coordinated efforts of all divisions of Columbia's Technical Staff—Research, Development, Technical Service and Market Research and Development. It is greatly aiding further utilization of the vast potentials of alkalies and chlorine—the basic production of Columbia.

Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth at Bellefield, Pittsburgh 13, Pa. Laboratories, Barberton, Ohio. District Offices, Chicago, Boston, St. Louis, Pittsburgh, New York, Cincinnati, Cleveland, Minneapolis, Philadelphia, Charlotte, San Francisco. Manufacturers of alkalies and related products, including Soda Ash, Caustic Soda, Liquid Chlorine, Sodium Bicarbonate, Calcium Chloride, Caustic Ash, Modified Sodas, Phosflake, Calcene T, Silene EF, Pittchlor and Pittcide.

COLUMBIA CHEMICALS

PAINT · GLASS · CHEMICALS · BRUSHES · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

Wood specimens which show the excellent preservative qualities of Pentachlorphenol. The two pieces on the right were impregnated with this protection against decay. All four pieces were buried underground for six years in a Dow test plot.

Chemistry gives lumber longer life . . .

Growing trees can fight their own battles against many common destructive forces. Nature has seen to that. But power poles, fence posts and structural lumber are dead wood and suffer greatly from insect attack and the conditions that create decay. Here's where the chemist steps in and takes over nature's job to give lumber longer life.

During the past decade, notable progress has been made in developing preservative treatments for the protection of wood. Studies undertaken by Dow technicians have resulted in a new preservative known as Pentachlorphenol which is being used successfully without the attendant disadvantages of the older commonly used materials. Pentachlorphenol gives every assurance of greatly extending the useful life of lumber.

Development of chemicals for treating lumber is only one phase of the work that is constantly underway at Dow. Our interests range from ultra-light magnesium to chemicals that promote the health of the Nation and the progress of every industry.

The scientific mind and the scientific method are of first importance to Dow.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

Nine-cent miracle

YOU ARE looking at a 9-cent piece of the hardest metal made by man.

It is Carboloy Cemented Carbide.

And this particular piece . . . one of a large number of standard blanks which sell for less than $1.00 . . . when used as the cutting edge of a metal-working tool, performs miracles in helping to speed up production, increase quality and cut costs of machined parts.

Carboloy costs steadily down

While this is only one of hundreds of Carboloy forms that range in use from tools and dies to masonry drills and wear-resistant parts, it dramatizes the *long downward trend* in the price of this miraculous metal.

For today, its low cost and remarkable hardness are taking Carboloy into many broad new fields. Housewives, hobbyists, home-owners and craftsmen are all experiencing the qualities of Carboloy at low cost.

That's great news for industrialists, too.

It means that all the extra benefits of Carboloy tools, dies and wear-resistant parts can be had at costs comparable to ordinary materials. And, considered by authorities to be "one of the ten most significant industrial developments of the past decade," Carboloy is rapidly becoming the standard wherever a versatile, hard metal is required.

An odds-on chance

The odds are 10 to 1 that Carboloy—the amazing metal of many uses—can be put to work by our engineers to give your products higher quality at lower cost. Why not call us in for consultation?

FREE SOUND MOVIE, "Everyday Miracles," available for business clubs, industrial groups, technical societies and vocational schools. Write to reserve your date for this dramatic 24-minute, 16 mm. film.

Carboloy Company, Inc., Detroit 32, Mich.

CARBOLOY

(REG. U.S. PAT. OFF.) CEMENTED CARBIDE © 1947 CARBOLOY CO.

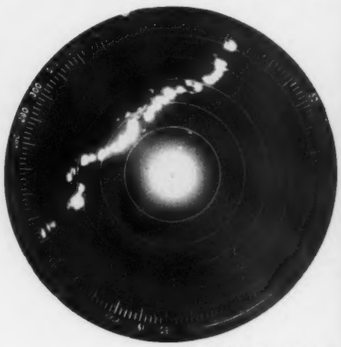
THE HARDEST METAL MADE BY MAN

AN EYE FOR WEATHER

(*Continued from page 30*)

equipment is the B-17, No. 44–8139, which is assigned by the army to the project. It is operated out of the Bedford Air Base by an army crew, which has volunteered for the duty despite the fact that the B-17, in the course of the investigations, is flown deliberately into the heart of the storm areas.

The plane has been successfully converted into a flying laboratory by the project. As has been already stated, the principal use of the plane will be as a platform from which to



M.I.T. Weather Project

A cold front moves in on Boston from the northwest as shown on a PPI (plan position indicator) scope. The distance between concentric circles is twenty miles, showing total range of 120 miles.

measure the various meteorological properties of a given ppt. area at the same time that the area is being scanned by radar. Since the plane moves so fast, it is imperative for the sake of good correlation between air and ground observations that the instrument lag be less than one second.

Among the more standard instruments carried by the plane are: the AAF angle of attack and yaw indicators; the AN/AMQ-2 aerograph, measuring temperature, humidity and pressure altitude; the ML-313 psychometer; a Radiation Lab thermometer; a radio altimeter; and a photobox installation including all flight instruments and several other measuring devices which are photographed at half second intervals.

The liquid water content of the air is measured by a capillary cup collector mounted up in the nose of the ship. This device utilizes surface tension forces in admitting water but not air. Icing rate is measured by a meter developed at Technology during the war.

(*Continued on page 36*)

Your enjoyment climbs to new altitudes through radio and television achievements of RCA Laboratories.

RCA LABORATORIES—your "magic carpet" to new wonders of radio and television

More and more people will go sightseeing by television as the number of stations and home receivers increases. Eventually, television networks will serve homes from coast to coast . . . bringing you the news as it happens . . . sports events . . . drama . . . vaudeville.

Many of the advances which have made possible these extended services of radio-electronics, in sound and sight, originated in research conducted by RCA Laboratories.

Recent RCA "firsts" include: ultrasensitive television cameras that give startling clarity to all-electronic television . . . tiny tubes for compact, lightweight portable radios . . . "picture tube" screens for brilliant television reception.

In other fields of radio-electronics, RCA has pioneered major achievements—including the electron microscope. Research by RCA Laboratories goes into every product bearing the name RCA or RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th St. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20.*

Continue your education with pay—at RCA

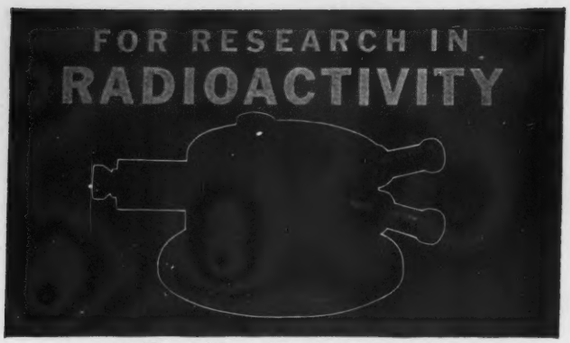
Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA



3¼" x 2⅜" x 1⅜"; Weight 3½ oz.

Lindemann Electrometer

This instrument was originally designed for use in connection with photo-electric measurements of light in astronomical work. It is now used extensively for the determination of radioactive emission. Compact and stable, it has high sensitivity, stable zero, and does not require levelling. The capacitance of the instrument is less than 2 cm. For general use, the instrument is placed upon a microscope stand and the upper end of the needle observed, illumination being obtained in the usual way through a window in the electrometer case.

Write for descriptive literature

CAMBRIDGE INSTRUMENT CO., INC.
Pioneer Manufacturers of Precision Instruments
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pH Meters and Recorders, Galvanometers, Gas Analyzers, Fluxmeters, Exhaust Gas Testers, Surface Pyrometers, and other Electrical and Mechanical Instruments for Use in Science, Industry and Medicine

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Why? Because Thermoid concentrates on a restricted line of products, related in manufacture and in use, and maintains those products at top quality level.

Thermoid, as a firm, is large enough to be thoroughly dependable, yet small enough to be sensitive to the day-to-day problems of its customers.

Engineers depend on Thermoid to always furnish well made INDUSTRIAL BRAKE LININGS and FRICTION PRODUCTS, TRANSMISSION BELTING, LIGHT DUTY and MULTIPLE V-BELTS and DRIVES, CONVEYOR and ELEVATOR BELTING, WRAPPED and MOLDED HOSE.

If catalogs on any of these lines would be helpful in your studies, we'll be glad to furnish them.

Thermoid Products
AUTOMOTIVE • INDUSTRIAL
OIL FIELD • TEXTILE
THERMOID COMPANY, TRENTON, N. J., U. S. A.

AN EYE FOR WEATHER

(*Continued from page 34*)

The most difficult instrumentation nut to crack was that of a device for measuring drop size distribution. Originally this distribution was measured by exposing paraffin-coated slides at regular intervals. This method was not very practical, though, because of the time it took to count and measure the drops, and useless for the larger drops because of splashing and evaporation effects.

The only two feasible automatic methods suggested were based on the measurement of impact of drops and measurement of drop attenuation of a light beam. The latter was found to be the most likely method; soon a "disdrometer," as the instrument was called, had been constructed in the project's workshops. It was mounted where raindrops from undisturbed air could pass through a light beam and momentarily attenuate it. The attenuation is converted by a photocell to an electric signal. The signals from the photocell are then indicated by an ingeniously devised electronic sizing and counting circuit which operates on a blocking circuit idea.

For a study of the crystals and snowflakes in a cloud, a gadget invented by Vincent Schaeffer of the G. E. laboratories was used. It consists of a long tube

(*Continued on page 40*)

A cross-sectional view of a storm front along an azimuth slightly south of west, as shown on an RHI (Range Height Indicator) scope. Bright echoes on right represent buildings in Boston, while lighter, vertical band at left portrays the actual storm front, curved at the bottom because of differences in wind velocity at different altitudes. *M.I.T. Weather Project*

Because photography is graphic...

Down go the curtains. Off go the lights. And as the film begins, the class becomes alert, attentive, absorbed. Photography is graphic . . .

Because it's graphic, educators use films to bring the breath of life into the classroom . . . to give new meaning to the teaching of history, science, mathematics, and other school subjects.

Because it's graphic, industry uses films to remove employee relations from the realm of the abstract . . . to give vivid impact to health and safety campaigns . . . to explain clearly the "hows and whys" in training programs.

Because it's graphic, advertisers use films to bring out a product's allure . . . to picture its promise in true-to-life detail . . . to arouse and hold their prospect's interest.

This characteristic—with others equally unique—gives photography broad applicational scope. For an introduction to some of its most important functional applications, write for "Functional Photography." It is free, of course.

Eastman Kodak Company, Rochester 4, N. Y.

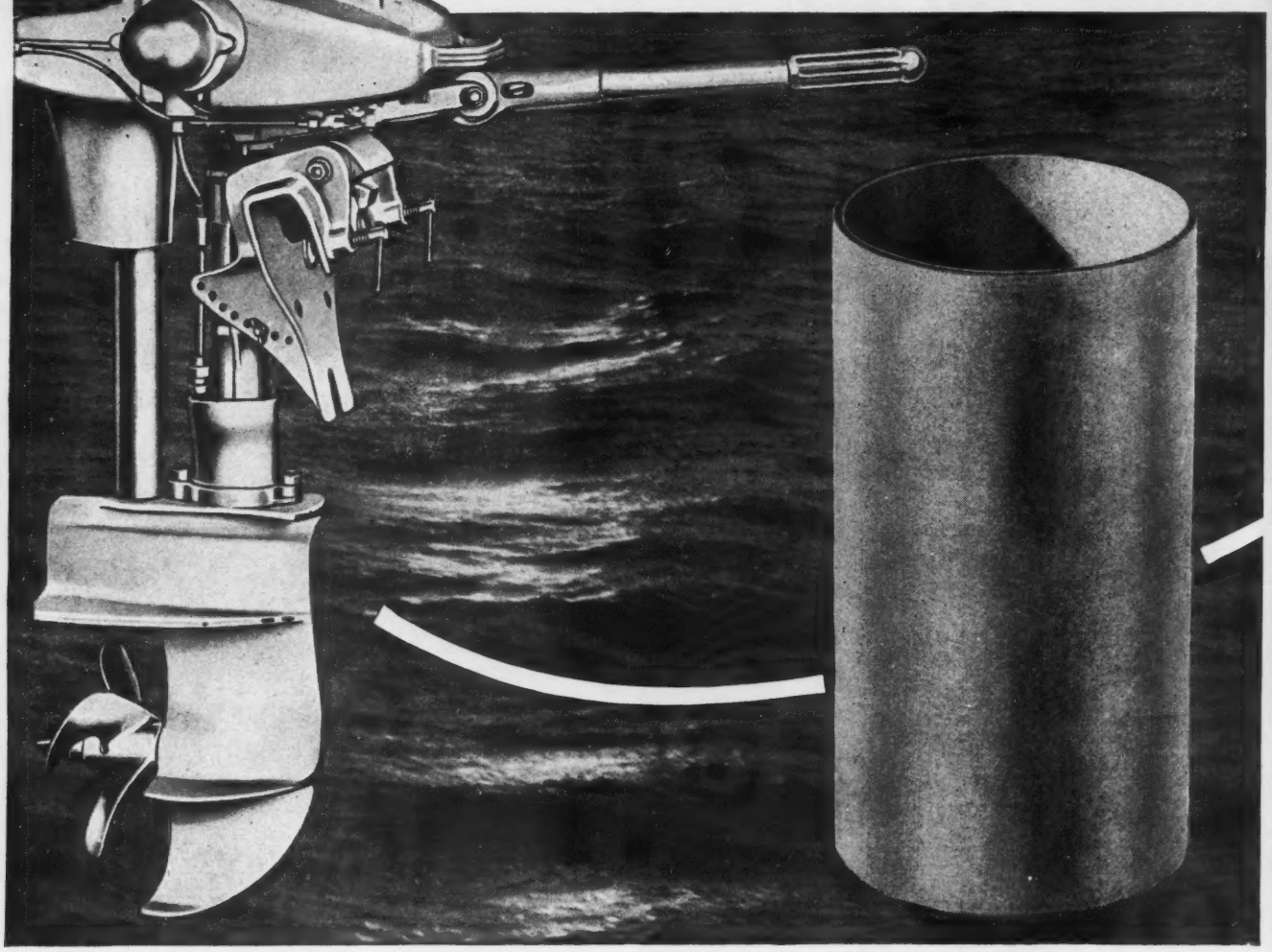
Functional Photography

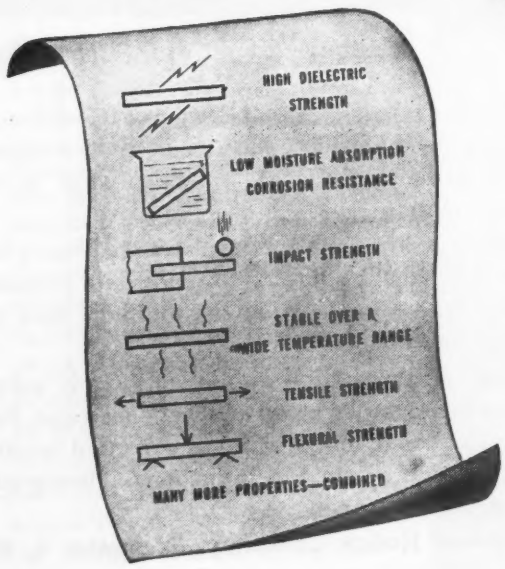
is advancing business and industrial technics

Kodak

Plastics where plastics belong

for resistance to moisture and wear





Synthane where Synthane belongs

It's Synthane—this outboard motor pivot bearing . . . requires no lubrication . . . resists both salt and fresh water, wears long and well. It's a good example of the use of plastics where plastics belong and Synthane where Synthane belongs.

Synthane (our type of plastics) is also light, dense, strong, easily and quickly machined, an excellent insulator, a material for fighting corrosion.

These and many other properties—combined—make Synthane adaptable to countless applications. Synthane Corporation Oaks, Pennsylvania.

SYNTHANE

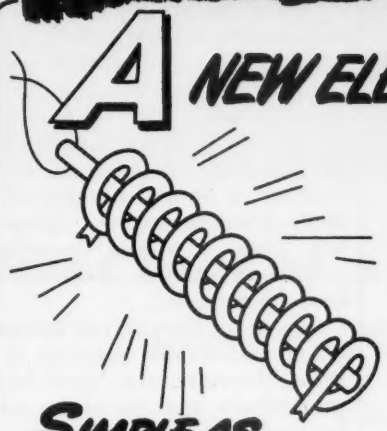
SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED

MIRACLE HEAT—
without fire or furnace!

HEATING A PIECE OF METAL BY OPEN FLAME, BLOW-TORCH OR FURNACE IS RELATIVELY SLOW—APT TO LEAVE SCALE... IT'S HARD TO HEAT ONE SPECIFIC AREA WITHOUT HEATING THE WHOLE PIECE.

PRODUCTION MEN REALIZED HEAT-TREATING OPERATIONS SUCH AS FORGING, PRECISION BRAZING AND SURFACE HARDENING COULD BE STEPPED WAY UP IF A FASTER METHOD OF HEATING COULD BE FOUND... ONE WHICH WOULD CONCENTRATE THE HEAT AT PRE-SELECTED AREAS!

HEAT BY INDUCTION SEEMED LIKE THE ANSWER. SCIENCE HAD ALREADY DISCOVERED THAT METALS HEAT RAPIDLY WHEN INTRODUCED INTO A HIGH FREQUENCY, HIGH DENSITY MAGNETIC FIELD!



A NEW ELECTRONIC HEATER DESIGNED BY ALLIS-CHALMERS SCIENTISTS—

AMAZING PRODUCTION TOOL RECTIFIES ORDINARY 60-CYCLE CURRENT THEN STEPS IT UP TO 450,000 CYCLES. A MAGNETIC FIELD OF HIGH DENSITY IS SET UP IN WORK COIL AND WHEN METAL IS INTRODUCED INTO THIS FIELD, PASSAGE OF CURRENT CAUSES POWER LOSSES WHICH PRODUCE HEAT WITHIN THE METAL WITH INCREDIBLE SWIFTNESS.

BIG BENEFITS: COMPLETE, SELECTIVE CONTROL OF HEAT PENETRATION... EXACT UNIFORMITY... GREATLY INCREASED PRODUCTION!

SIMPLE AS

A PLACE METAL IN WORK COIL...

B PUSH BUTTON

C METAL IS HOT IN SPLIT SECONDS

ALLIS-CHALMERS MANUFACTURING CO. MILWAUKEE 1, WIS.

ELECTRONIC HEATER IS ONE MORE EXAMPLE OF HOW ALLIS-CHALMERS RESEARCH AND EXPERIENCE GO TO WORK FINDING BETTER, FASTER, MORE EFFICIENT WAYS OF HANDLING PRODUCTION PROBLEMS—ANOTHER GOOD REASON WHY A-C EQUIPMENT IS IN DEMAND IN EVERY MAJOR INDUSTRY...

ALLIS CHALMERS

ONE OF THE BIG 3 IN ELECTRIC POWER EQUIPMENT
BIGGEST OF ALL IN RANGE OF INDUSTRIAL PRODUCTS

It's NORBIDE*. . .

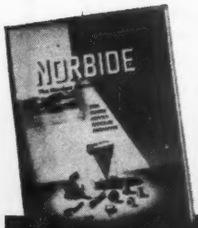
A Norton development that's mighty useful to industry

A product of Norton research, its unique characteristics make it very helpful in three entirely different ways —as an **abrasive** for lapping superhard materials—in **molded form** where extreme resistance to wear is desired—or for **metallurgical** use as an alloying agent.

Norbide is the trade-mark for Norton Boron Carbide, a material produced by fusing two commonplace materials, boric acid and petroleum coke, in the electric furnace at terrific temperatures. It is harder than any material except the diamond.

Not only is Norbide* extremely useful as an abrasive but because it is self-bonding under high pressure at high temperatures, it can be molded into a variety of products that are finding wide application for their exceptional resistance to wear and other unique properties.

The fascinating story *of Norbide products and their many interesting applications is described in catalog 378-CP. Every engineering student will want a copy. Write today —no obligation.*



NORTON COMPANY, WORCESTER 6, MASS.
Behr-Manning, Troy, N. Y. is a Norton Division

*Registered trade-mark for Norton Boron Carbide

NORTON

ABRASIVES — GRINDING WHEELS — GRINDING AND LAPPING MACHINES
REFRACTORIES — POROUS MEDIUMS — NON-SLIP FLOORS — NORBIDE PRODUCTS
LABELING MACHINES BEHR-MANNING DIVISION COATED ABRASIVES AND SHARPENING STONES

AN EYE FOR WEATHER

(*Continued from page 36*)

mounted in the nose of a B-17 which decelerates incoming flakes so that they will not be smashed when they finally are completely stopped. Plastic replicas are immediately made of all the captured flakes for future study at leisure.

By far the most difficult problem in the whole program was that of properly co-ordinating the enormous number of measurements. Rather elaborate techniques involving a VHF (very high frequency) intercommunications system between ground and plane and a full time plotter for the tracking of plane and storms on a map of New England, were developed for directing the plane into precipitation areas from the ground and at the same time making radar surveys of the area containing the plane. All measurements are timed by exactly synchronized clocks.

There is room for improvement in both the techniques and equipment of the project, but any important revisions will wait until a solid foundation of a sizeable fund of experience and data has been acquired.

Since the project has only been in existence a little over a year, it is not to be expected that much in the way of final results has been accomplished. In addition, the project has been continually dogged by bad luck in the form of good weather, a normal number of accidents, breakdowns, etc. Altogether, less than a dozen co-ordinated ground-air studies of storm areas have been made.

Even so, the analysis section has made considerable progress in analyzing the material at hand. Already, preliminary analysis of the relation between winds at various heights and precipitation echo movement has shown that precipitation echoes move in the direction of the wind at 500 millibars with about 70 per cent of the wind's speed. In addition, a relation has been found between the wind sheer and echo slope; so if both of the latter are known, approximate particle size can be calculated. Furthermore, radar echo strength profiles of several showers have been made and can be correlated in some cases with liquid water content measurements. If the work of analysis continues to prove as fruitful, the new science of meteorology will be greatly benefited. At the least, the value of an important aid to normal weather forecasting will have been increased by the results of the project, and at most—who knows?

WHAT PART OF A PLANE IS THIS?

Clue: 31,700 would cover a pinhead

It is part of the wing surface . . . an area so microscopic that 31,700 spots like this would barely cover a pinhead

You are looking at aluminum through an electron microscope, the way Alcoa Research scientists look at aluminum alloys in our laboratories. They get down to aluminum's *really* fine points . . . explore among the atoms.

Studying structures like this is one of the ways Alcoa metallurgists learn how to improve aluminum alloys and how to make new ones. By scientific experimentation they combine with aluminum the *right* amounts of the *right* metals to produce the results they want . . . alloys as strong or stronger than structural steel, at one-third the weight . . . alloys that make better castings, forgings, extrusions . . . alloys for innumerable uses

You wouldn't hear half, *not even a hundredth* as much about aluminum today if it weren't for these alloys that Alcoa Research has produced. Aluminum's great and growing usefulness springs directly from their development. Nature made aluminum light. Alcoa has made it strong and versatile and low in cost. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

MORE people want MORE aluminum for MORE uses than ever

ALCOA FIRST IN ALUMINUM

AIR... hot enough to melt bricks

Ever see a brick melt in air—melt like a block of butter in a warm room? Probably not. For air around the ordinary brick building just doesn't get that hot...over 2000°F. Yet raising the temperature of air until it's hot enough to melt a brick — and a lot hotter — is now possible with the Pebble Heat Exchanger developed by B&W. It heats gases far above the temperature limits of metallic heat exchangers.

Development of the Pebble Heat Exchanger is further evidence that B&W—old in experience, pioneer of many advances in divergent fields—is still young enough to have new ideas.

B&W offers excellent career opportunities to technical graduates in diversified phases of manufacturing, engineering, research, and sales.

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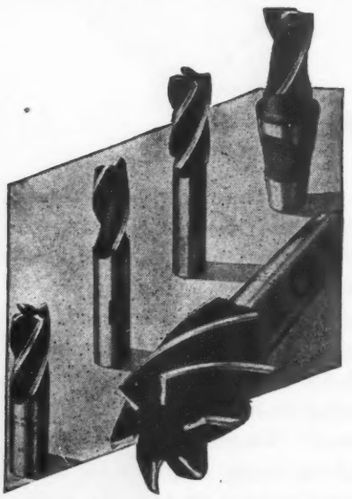

- Spiral End Mills
- Two Lipped Spiral End Mills — Small Helix Angle
- Two Lipped Spiral End Mills
- Long Spiral End Mills
- Long Two Lipped Spiral End Mills

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FROM THE extensive Brown & Sharpe line select the end mill that meets your particular needs — a fast, free cutting end mill that will give you maximum production. There's a style and size for every job. Brown & Sharpe Mfg. Co., Providence 1, R. I.

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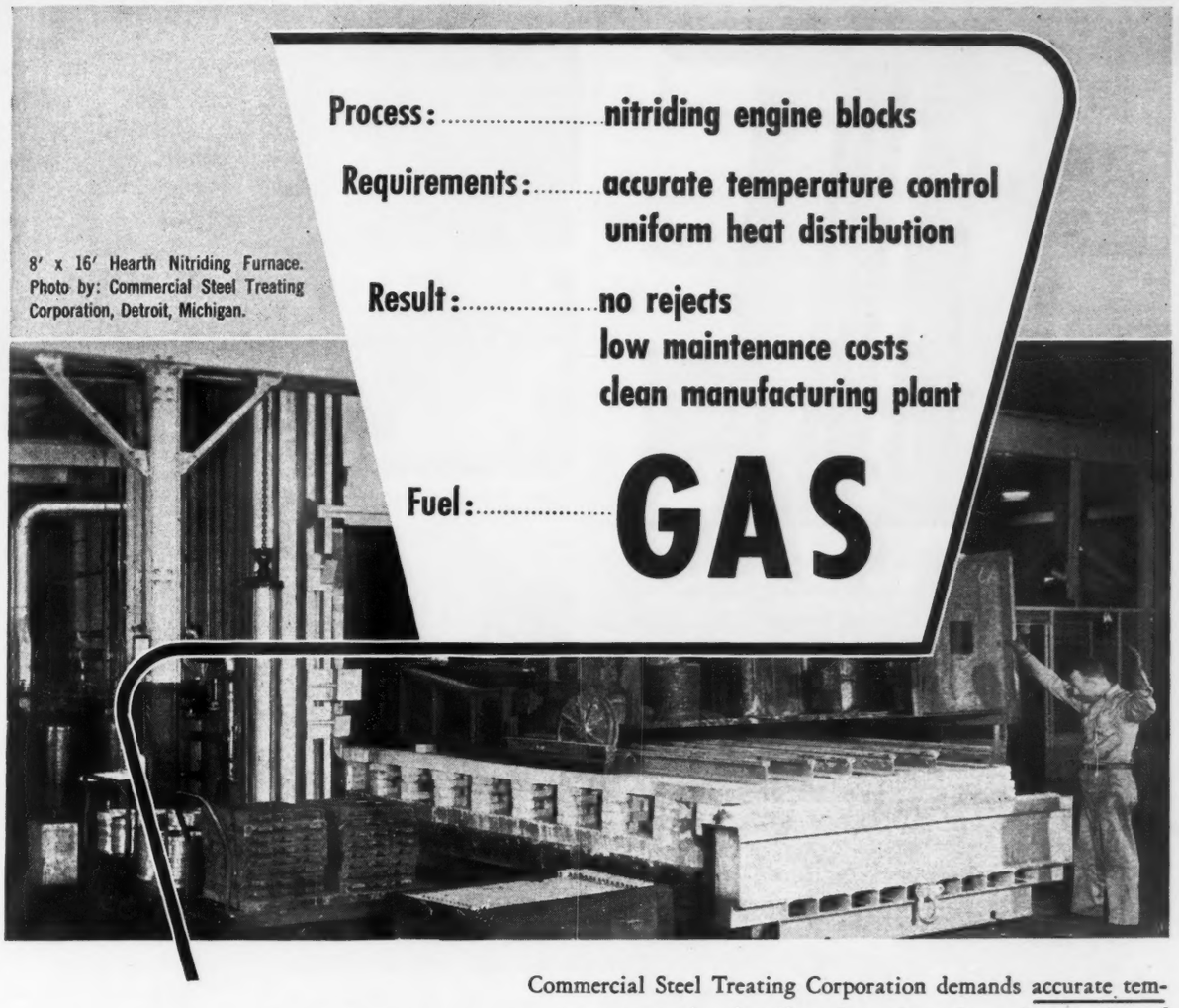
"Tagged Molecules"

THE STORY OF
THE USE OF TRACER
ISOTOPES IN BIOLOGY



8′ x 16′ Hearth Nitriding Furnace. Photo by: Commercial Steel Treating Corporation, Detroit, Michigan.

Process: ..... **nitriding engine blocks**

Requirements: ..... **accurate temperature control**
uniform heat distribution

Result: ..... **no rejects**
low maintenance costs
clean manufacturing plant

Fuel: ..... **GAS**

Capacity and product specifications for the GAS-fired furnace include:

- **Temperature**.....**975 degrees F.**
- **Allowable Variation**.....**±5 degrees F.**
- **Process Time**.....**96 hours**
- **Case Depth**.....**0.025 inches**
- **Atmosphere Supply**.....**Ammonia**
- **Production Rate**.....**200 Tons per Month**

Commercial Steel Treating Corporation demands accurate temperature control and uniform heat throughout the chamber of its heavy-duty nitriding furnace. GAS fulfills these requirements; five years of successful operation supply the proof.

GAS, dependable fuel for industrial processing operations, meets the most exacting control and heating requirements. Low maintenance costs and cleanliness characterize GAS-fired installations.

Vast new fields for physical and chemical research have been opened by demands in the metal working industry for more extensive use of controlled atmospheres for changing internal and surface characteristics of metals. GAS has become firmly established as the ideal fuel for controlled atmosphere processing.

AMERICAN GAS ASSOCIATION
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FOR ALL INDUSTRIAL HEATING

short facts about long-lived cable

• In Okonite cables, copper conductors are effectively protected by Okoloy coating which outlasts tinning at least 2 to 1. The Okonite Company, Passaic. N. J.

look for the single ridge

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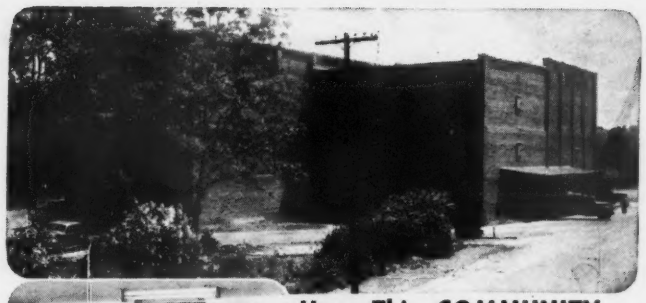
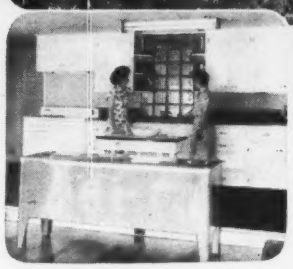
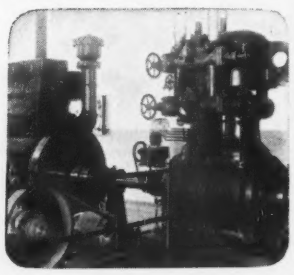
insulated wires and cables
for every electrical use





Home Economics Department, Thomasville Ice & Mfg. Co.



One of Five Frick Refrigerating Machines in Service at Thomasville.

How This COMMUNITY REFRIGERATION CENTER Serves Southcentral Georgia

The Thomasville Ice and Mfg. Co. produces 130 tons of ice daily, ices many railway cars and trucks; stores great quantities of pecans, one-half million pounds of peanuts, quantities of pimento peppers, blueberries, pears, okra, tung oil nuts, and lupin seeds; rents 475 frozen-food lockers; conducts home economics demonstrations; will soon install bulk quick-freezers.

Its two plants at Thomasville give Southern Georgia and Northern Florida an invaluable service.

This firm has used Frick Refrigeration and ice-making equipment exclusively for 35 years.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, now in its 31st year, is approved under the G. I. Bill of Rights.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

A LOOK AT TELEVISION

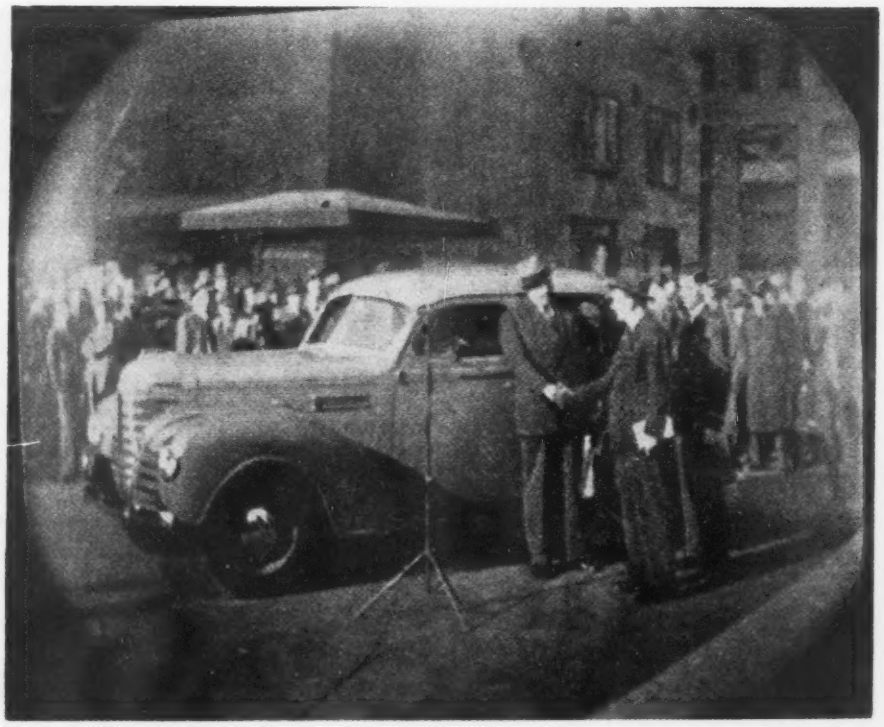
(*Continued from page 15*)

But geographical coverage is another problem entirely. As has been mentioned, television is limited by the fact that it can only be received by direct beam from the antenna. Its waves do not bounce off the Heaviside layer of the atmosphere as do broadcast band radio waves, with the result that reception is limited by the approximate rule of "line of sight" between the receiver and transmitter. Translated into simpler terms, it can be said that a clear picture can be obtained for the first twenty miles from the transmitter. After that the antenna must be proportionally higher to bring in the same quality picture.

Naturally, when stations in different cities combine their efforts, bigger and better programs can be offered. This is a simple matter in the field of broadcast band radio. But the "line of sight" limitation severely restricts such television network combinations. Three solutions have been offered to date. The first is simply the use of co-axial cables between various transmitting

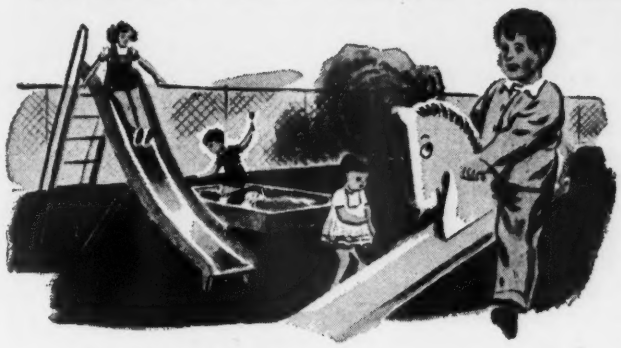
(*Continued on page 46*)

Nine years ago, on November 10, 1938, this preview of a 1939 car was televised from Rockefeller Center. Technical progress has by now advanced the quality of pictures to the point where they appear to be about the same as a first-rate photograph taken at the scene. *Acme Newspictures, Inc.*

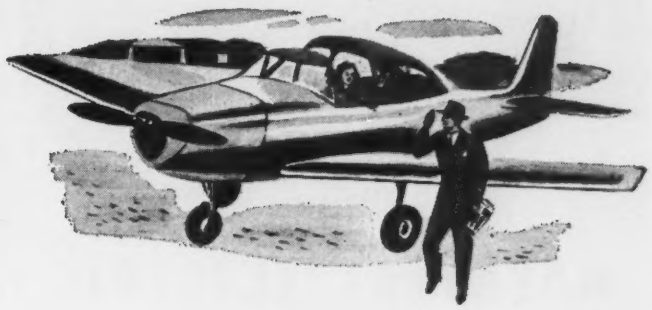


QUESTION:

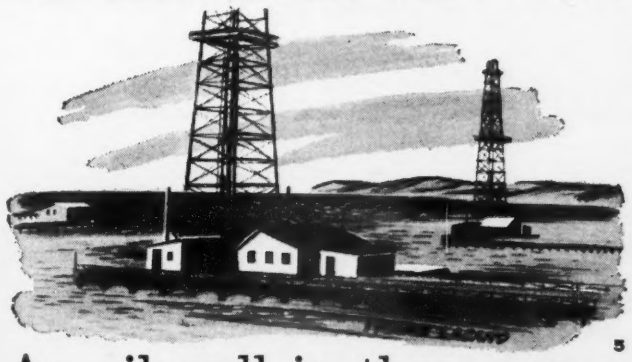
What do these things have in common?



A children's playground[1] . . . . a private pleasure plane[2] . . .



An interurban bus[3] . . . . . a battery of coke ovens[4] . . .



An oil well in the ocean[5] . . . . and a deadly insecticide[6]?

ANSWER:

They've all been made more efficient by the engineering or chemical skill of Koppers

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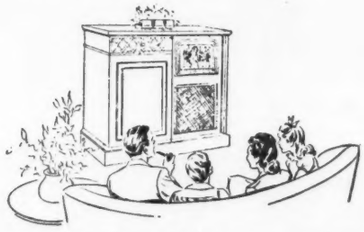
A LOOK AT TELEVISION TODAY

(*Continued from page 44*)

centers. Such arrangements have proved to be satisfactory to the extent that New York, Washington, and Philadelphia are now connected by such cables.

The second solution to the geographical problem involves the use of microwave relay towers. Effectively these towers receive the signal in microwave form and rebroadcast it as similar microwaves to the next tower, which rebroadcasts the signal on to the next tower, and so on. This system has also been successful and has been put into service between New York and Boston, with towers erected roughly every thirty miles. Finally, there is the proposed use of the so-called "Strato-vision" plan, using planes flying in the stratosphere as transmitting antennas and thus greatly increasing the range which can be covered by a single antenna. While the plan is feasible and technically possible, it is not expected to appear on a commercial scale.

Finally there is the problem of maintenance. When a television receiver breaks, skilled repair is absolutely necessary due to the intricacy of the set. At present there is a tremendous shortage of such trained repair personnel in the television field. This shortage is expected to continue for many years to come, until the average intelligence of the radio-repair man rises to such a level that he can comprehend the difficulties involved in tinkering with a complicated, forty-tube video system. At present, television companies are themselves short of such skilled labor and have had to rely upon the efforts of the dealer and distributor to supply such maintenance services as can be offered. The situation is definitely serious and promises to continue that way for some years.



It's just as much fun and just as cozy to view televised entertainment on a smaller screen as on a larger.

A word now about color television. While many premature articles in technical magazines predicted that color video systems would be ready after the war, and while a successful demonstration under carefully controlled conditions has been made, color television is far, far from technical perfection. It is estimated that color television is six or seven years in the future — and many men in the field are seriously questioning the need for color in the light of similar results in the movies, where, despite all the fuss about Technicolor, only six per cent of all films now produced are produced in color. If color television does materialize, its appearance on a commercial scale is still many years off.

Television itself is now past the experimental period and is definitely here to stay. But it will stay only so long as it is carefully administered and advertised to be just what it is: a source of primary entertainment for those who can afford it and who can realize the difficulties involved in obtaining clear, well-defined images in our world of skyscrapers and large distances.

Briefing the News . . .

(*Continued from page 4*)

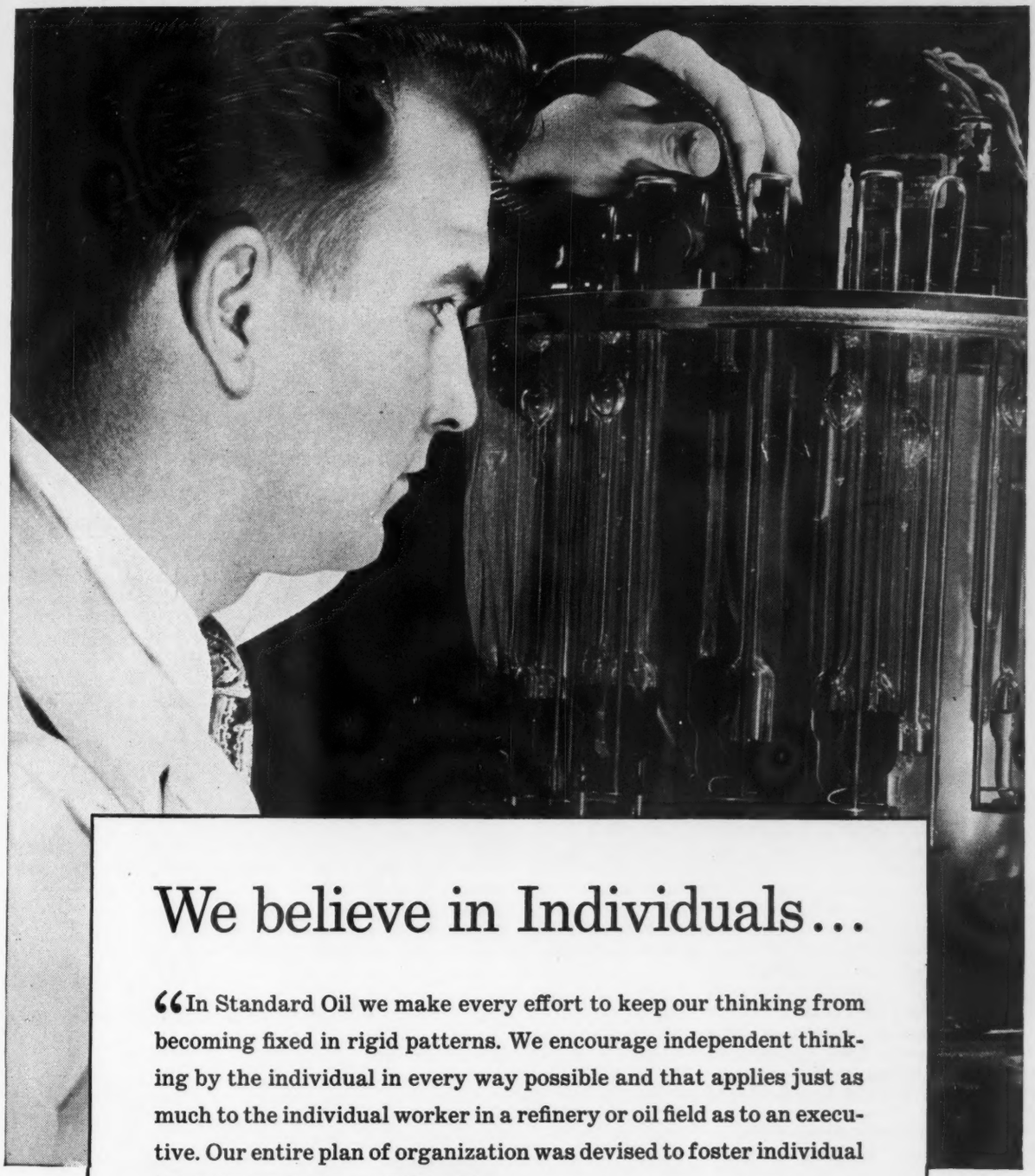
The Homing Pigeon's Secret . . .

At last a solution has been found for the age-old problem of why homing pigeons fly home. Using some sort of "navigation instrument" more sensitive than any man has been able to build, the pigeon is directed to its destination by a combination of the earth's magnetic field and the torque exerted on the pigeon by the earth's spin. According to Professor Yeagley of the Pennsylvania State College, who discovered this fact, the "navigating instrument" may be located on the end of the optic nerve in the eye, in a small, mound-like structure extending about three-quarters the distance across the eye.

The discovery of the principle upon which the pigeon directs its journey took place when hundreds of homing pigeons trained at Pennsylvania State College were released in Nebraska. Instead of returning to their home loft, they all gathered at a certain spot in Nebraska, the only other spot on earth having the same latitude and the same magnitude and direction of the earth's magnetic field as the Pennsylvania college. During experiments with birds that were released at positions closer to the college, it was found that pigeons liberated nearer than halfway to the college flew home, while the others congregated in Nebraska.

Professor Yeagley points out that for every point on the earth there is a companion point with the same latitude and magnetic field, and that a pigeon liberated farther from its home than from its companion point will fly to the latter location.

Laboratory technician measuring the viscosity change in petroleum products.



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From an address by Eugene Holman,
President, Standard Oil (New Jersey).

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TAPES — RULES — PRECISION TOOLS

INFRARED TELESCOPE

(*Continued from page 18*)

One such modification was the Navy's infrared telescope, an instrument designed primarily for signaling at sea. It employed a reflective objective system for focussing the infrared beam on the photosensitive cathode of the infrared tube. As shown in the lower part of Figure 1, a spherical mirror reflects the infrared beam to a small plane mirror which in turn directs the light to the photoelectric surface. A corrector plate is placed in the path of the incoming light beam to correct for the various distortions that would otherwise have appeared in the phototube image. The reflective system has a focal length of 2½ inches and an aperture of 2⅞ inches. With this remarkably low focal ratio of f/0.9 (focal length nine-tenths of the diameter of the objective), the instrument is highly sensitive and had a very wide field of view. Used to pick up code signals sent by infrared light from one vessel to another, the instrument enabled communication to be carried out over distances of many miles in total darkness.

During the war the Radio Corporation ran many experiments to find a way of adapting the *snooperscope* as a binocular instrument for the use of drivers. Since armored attacks were often carried out under conditions of negligible illumination, a device enabling the driver to see in the dark would have been of great value. Most of the devices designed were too topheavy to be used without any support, but finally there was developed a periscope type of instrument that could fit onto the helmet of the driver of a tank. The bent shape of the instrument left room for the focal length of the objective lens system and for the image tube, while the compact form of the instrument made it easy to wear.

In addition to its many applications in time of war, the infrared telescope will have a multitude of uses in peacetime as well. It has just been released from classified (or restricted) status by the armed forces, and may be expected to go into civilian production soon. A few of the infrared telescopes have supposedly been released for sale as army surplus for around a hundred dollars, while the image tube is also believed to be on sale for about five dollars. One of the most important peacetime applications of the *snooperscope* will undoubtedly be to aid watchmen in guarding property at night. Police departments will probably be prominent users, too. The instrument may be used by airplanes at night or to cut through some types of haze, although infrared radiation, like visible and ultraviolet radiation, is unable to penetrate fog, being reflected by the fog droplets. The device may also be used to watch the development of films that must be developed in the total absence of visible light. It will also be of great assistance in infrared photography, since the eye can then see what the camera will photograph, and it may even be possible to take infrared photographs through the instrument.

My thanks go to Mr. E. T. Dickey of the Radio Corporation of America for his assistance in furnishing information and photographs for this article.

A laboratory prototype of the snooperscope, *showing in a compact form the design of the instrument. The infrared telescope is at the top of the instrument, while the lamp used to supply infrared radiation is attached beneath. The batteries and power supply are in the satchel, and the high-tension voltages of the power supply are fed to the* snooperscope *by the rubber-covered cable.* *Radio Corporation of America*

If the devil drank tea he could use this cup...

NO, this picture isn't faked. It shows white-hot molten metal being poured into a little glass dish resting on ice.

This is Corning's "Vycor" brand 96% silica glass, a result of the first really new glassmaking process in over 2000 years. It can withstand sudden extremes of hot and cold without breaking, and temperatures up to 2000° F. without melting. It is one of the hardest, most acid-resistant, and electrically-resistant glasses known. And it has already opened up new fields in many industries.

Now it is ready to go to work to make cooking easier, cleaner, and safer for millions of women... as a burner plate on a modern gas range, soon to be announced. The smooth glass plates will distribute heat more evenly and give firm support to even smallest utensils. And they will keep spilled food from clogging burners.

Corning began its search for heat-resistant glasses years ago when it was asked by railroads to supply a glass for brakemen's lanterns that wouldn't shatter when a gust of cold rain hit it. This was the forerunner of the famous Pyrex brand glasses which have since found their way into thousands of industries in such diverse form as glass piping, laboratory ware, and ex-ray tubes, and into millions of homes as Pyrex Ovenware and Flameware cooking utensils.

Corning not only knows glass, but knows how to make it work. It has the finest glass research organization and the finest group of skilled workers in the world... a hard-to-beat combination that will be at your service whatever career you choose. In the meantime, learn all you can about glass and if we can help answer any questions, call on us. Corning Glass Works, Corning, N. Y.

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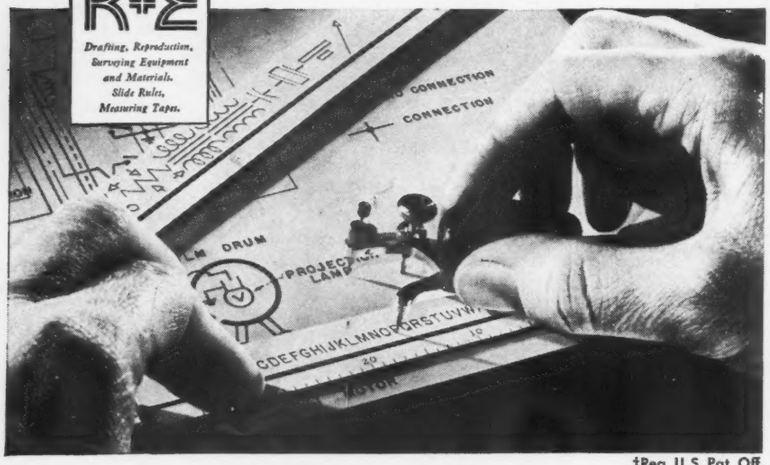

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WATER WATER EVERYWHERE

(*Continued from page 25*)

cals, were all tried and found wanting.

The method of "shock" treatments was found to be at least fairly effective as long as a thick scale had already formed. In this method the evaporator was shut down as quickly as possible so as to cause a minimum lowering of the temperature of the metal parts. As soon as the shells were drained a jet of cold sea water was put on the tube nests. Since the metal tended to contract faster than the scale formation large portions of the scale cracked and fell off. This scale was gathered up at the bottom of the shell and cleaned out through the "clean-out" plates on the front of the shells. This system had the serious disadvantage of tending to cause the tubes to pull out of the tube nest headers, thus causing leaks.

The method of using starch and "Navy Boiler Compound" treatments was also attempted. This method consisted of the constant feeding of starch and boiler compound into the salt-water feed. The starch and compound tend to slow down scale formation and cause those scales which do form to be softer and thus easier to remove by mechanical methods. The disadvantage of this method was that in case of slight carry over of brine the compound also carried over. This compound seems to have a bad effect on the digestive tract, acting more or less like a powerful laxative.

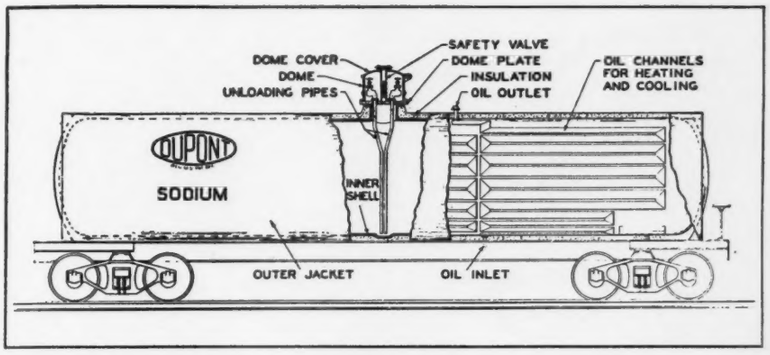
The use of chemical compounds of an acid nature was found to be highly effective, many so effective that certain engineering officers are still trying to explain where their evaporators disappeared to.

An SBD takes off from one of our carriers in the Pacific *Official United States Navy Photograph*

Du Pont *Digest*

Items of Interest to Students of Science and Engineering

Industrial Organic Applications of Metallic Sodium



Sodium for organic reactions is shipped in 80,000-lb. quantities. It is pumped into the car, solidified by cooling and melted by hot oil for removal.

There would seem to be a considerable gap between the electrolysis of salt to make sodium, and research in the field of organic chemistry. However, at Du Pont as much emphasis is placed on organic research to develop outlets for sodium as on its inorganic uses.

For more than 15 years, intensive work on industrial uses for sodium has been carried on in Du Pont laboratories and plants by chemists, physicists, chemical, mechanical and electrical engineers.

In the organic field, this research has contributed a number of important uses for sodium such as the reduction of fatty esters, particularly of natural glycerides, to alcohols.

$$C_{15}H_{31}\overset{O}{\overset{\|}{C}}\text{-OR} + 4Na \xrightarrow[\text{solution}]{\text{alcohol}} C_{15}H_{31}CH_2OH + 4RONa$$

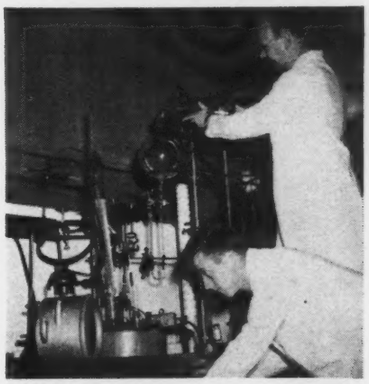
Du Pont organic chemists have found that sodium with selected secondary alcohols, such as methyl amyl alcohol, in the presence of toluene or xylene, eliminates shortcomings of the classical method involving ethyl alcohol and sodium. Practically quantitative yields of the higher molecular weight alcohols are obtained.

This new method is especially useful in preparing unsaturated alcohols not easily made by catalytic hydrogenation. The process can be carried out at atmospheric pressure and compares favorably with catalytic hydrogenation of saturated, higher fatty esters because of the simplicity of operation and equipment.

The discovery of the new reaction conditions has led to the use of millions of pounds of sodium annually for manufacture of long-chain alcohols for wetting and emulsifying agents and synthetic detergents.

Other important processes developed by Du Pont organic research include the use of sodium for reduction of fatty esters to corresponding long-chain acyloins, and reduction of nitriles to primary amines.

Du Pont has also contributed to the development of many other uses for sodium and its simple derivatives, such as in the manufacture of tetraethyllead, used in high-grade motor fuels, dyestuffs synthesis, and descaling of alloy steels. In the form of sodium hydride or sodium alkoxides, sodium is a catalyst for many Claisen condensations, useful in the manufacture of barbiturates, sulfa drugs, vitamins, keto-acids and diketones.



Preparing to carry out an organic condensation reaction involving the use of sodium, R. B. Clark, B.S., West Virginia University '42, and W. J. Hilts, M.S., Syracuse '36.

Questions College Men ask about working with Du Pont

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Her compact passed 65 screen tests

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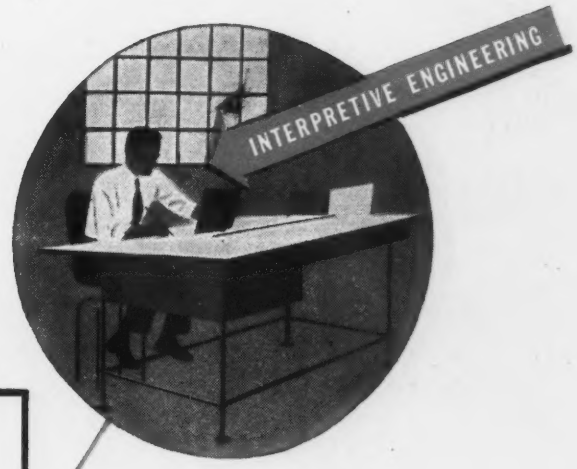

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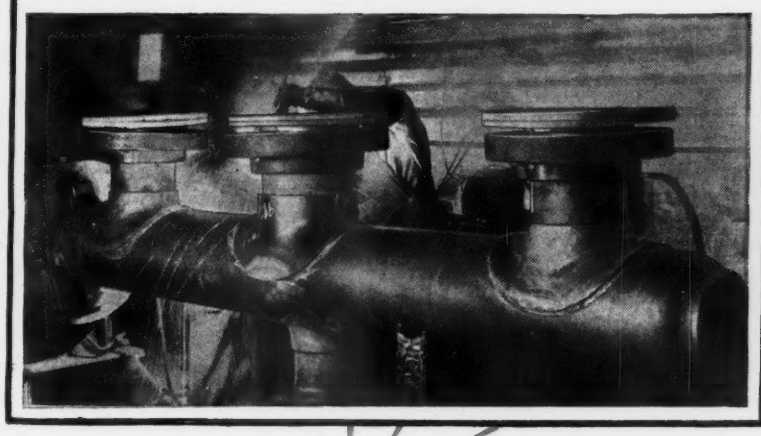

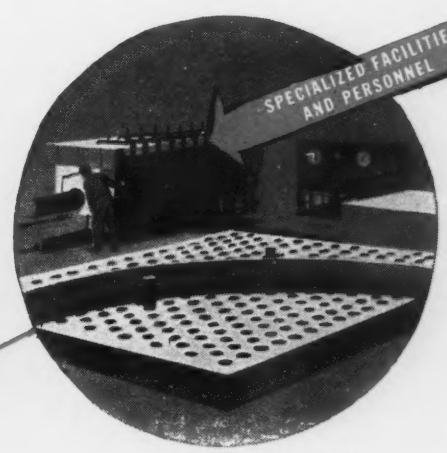

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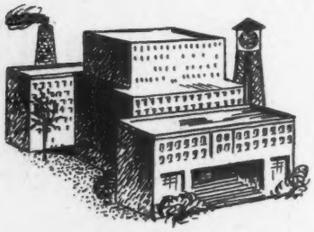

Organosilicon chemistry dates back almost a century. But only in recent years did General Electric begin investigating silicones for industrial uses. With the war, the amazing heat- and cold-resistant properties of silicone products found several important applications (like silicone rubber gaskets for superchargers). And now, with a new plant completed at Waterford, N. Y., General Electric silicones can begin to flow in quantity to many types of industries.

WHAT THEY ARE

Just what are silicones? General Electric silicones are products of research—highly versatile synthetics derived by "crossing" organic and inorganic substances. The combination results in an entirely new and prolific family, in which the virtues of each parent are dominant, while the undesirable characteristics are recessive or completely eliminated.

A silicone's basic chemical structure is a silicon-oxygen molecule derived from sand. The insertion of organic groups into this purely inorganic silicon-oxygen combination endows it with plasticity, flexibility, and workability, without appreciably lessening its inherent virtues of heat, chemical and weather stability.

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Where can these products of G-E silicone research be applied? Here is a listing which indicates some uses, by categories:

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3. SILICONE RESINS: Electrical insulation; paints, enamels and similar protective and decorative finishes; plastics. and adhesives.

4. SILICONE RUBBER: Gaskets for oven doors, searchlights, vacuum chambers, refrigerators, capacitor bushings; coated cloth for diaphragms and insulating tapes, and de-icing applications.

5. DRI-FILM* WATER REPELLENTS: Liquid compositions for treating paper, cloth, plastics, asbestos, glass, ceramics, powders, and leather.

● At General Electric the doors to silicone research have been swung wide. Possibilities for further development are virtually unlimited—awaiting only the imagination, knowledge, and skill of today's and tomorrow's chemists. For more information write *Chemical Department, General Electric Company, Pittsfield, Massachusetts.*

*Reg. U. S. Pat. Off.

A message to students of chemistry and chemical engineering from

DR. A. L. MARSHALL

Head of Chemistry Division
General Electric Research Laboratory

The progress made in the field of organosilicon chemistry is only a prelude to that which can be expected in the near future. Young technical men of today—and those seeking a fascinating branch of chemistry toward which to direct their studies for tomorrow's research—will do well to investigate thoroughly the opportunities for endeavor offered by organosilicon chemistry.

GENERAL ELECTRIC

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PLASTICS ● SILICONES ● INSULATING MATERIALS ● GLYPTAL ALKYD RESINS ● PERMANENT MAGNETS